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PLANT OF THE RAIKE-HEALY BUILDING

Successful Small Plant Furnishing Heat, Light and Power for Various Industries in Building

AN EXAMPLE OF THE successful operation of an isolated steam plant is found in the Raike-Healy building, Chicago. The plant is of 160-kw. capacity, and might be classed as a small central station, the consumers in this case being the various manufacturers located in the building. To these tenants are supplied heat, light, power for a variety of motors ranging from ⅛ to 25 hp., and elevator service. Of course, the elaborate auxiliary appliances which aid in the efficiency of the large power station were not practicable in this instance, because of the small size of the plant and the large first cost of such equipment, but the compact arrangement of the apparatus and economy in operation have aided in securing satisfactory results.

Steam is supplied by 2 Brownell boilers of the horizontal return tubular type, 66 in. diameter, 18 ft. long, and 117 hp. each. These boilers are fired by hand, being equipped with stationary grates. A working pressure of 110 lb. is maintained, although 139 lb. is permitted by the city inspector.

A noteworthy feature is the arrangement of combustion arches at the bridge wall. Two central piers, together with the side walls, form a triple mixing arch, the top of which closely hugs the boiler shell. By this device, the current of gases is broken up and more of the directly radiated heat is utilized for making steam. Pocahontas coal serves as fuel and although the plant has been in service for nearly 3 yr. no complaints have been received for a violation of the smoke ordinance.

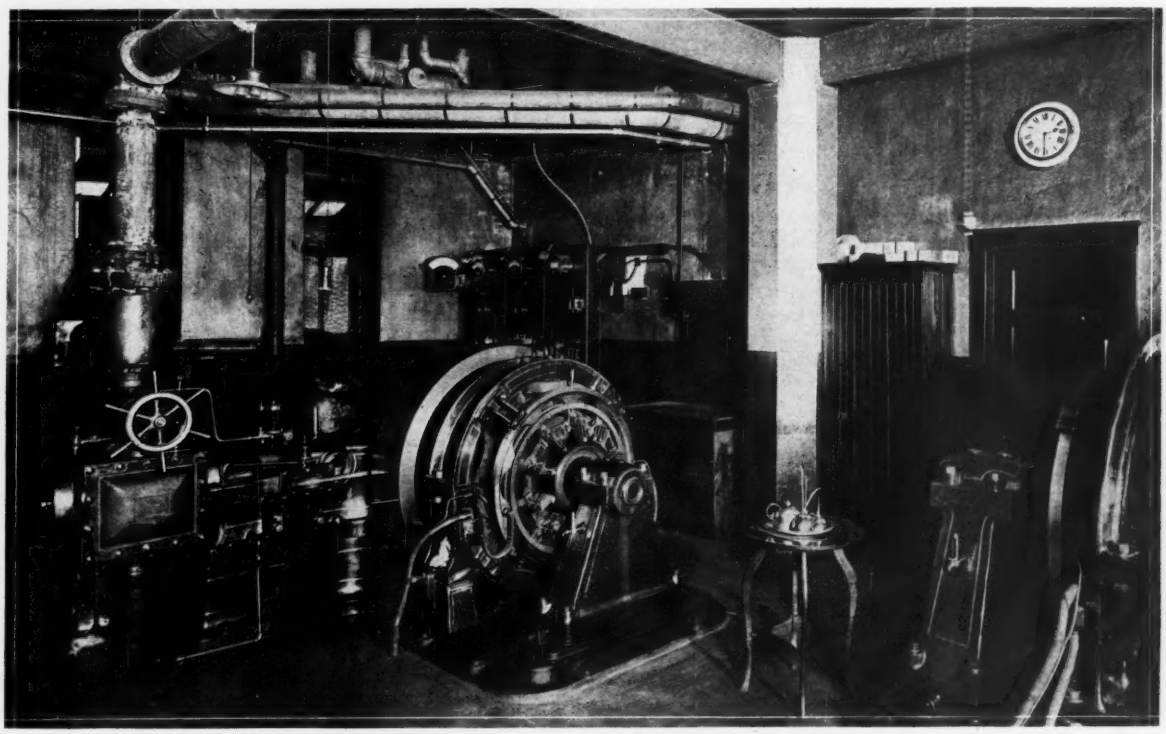


FIG. 1. VIEW IN ENGINE ROOM, SHOWING ONE OF THE GENERATING UNITS

From a small covered court in the rear of the building, coal may be delivered direct to a storage of 20 tons capacity, or shoveled into a chute which leads to a position directly in front of the boilers. Material for starting the fires is provided through a fireproof rubbish chute extending up through the building with its lower opening in the boiler room.

When cleaning fires, the dead plates in front of the fire doors can be raised and the ash and clinker raked directly into the ashpit without littering the boiler room floor, a trouble which is common in cases of hand fired boilers.

Piping

ONE of the principal factors which aid in the plant's efficiency is the simplicity of the steam piping system. Through 6-in. steam connections provided with angle valves, the steam passes from the boilers into a short 12-in. header extending over the rear of the boilers. At the junction of these connections with the boiler nozzles are crane combination angle stop and nonreturn valves. From the header, lead 5 branches, one a 2-in. blowoff pipe, 2 carrying steam to the pumps and heater, while the remaining 2 run to the engines, connecting with the steam separators just above the throttle.

through a 1½-in. feed line, at a temperature of about 208 deg.

The pumping apparatus consists of 3 6 by 4 by 6-in. Deane of Holyoke pumps, 1 being used for house service and 1 for feeding the boiler, the third being reserved for an emergency. All 3 are cross connected and may be used for either boiler feed or house service. Dearborn boiler compound feeders are installed on the suction line between the heater and the pumps.

In addition to this set of pumps, there is a 12 by 3½ by 12-in. Burnham steam pump which furnishes hydraulic pressure for hydraulic presses on the third floor of the building. Ordinarily it supplies pressures from 1 to 500 lb., but has a capacity of 900 lb.

Heating System

USED in conjunction with a Reliable hydraulic vacuum pump, a Bishop-Babcock-Becker air line system containing 8000 sq. ft. of direct radiation, supplies the building with steam heat. There is a single steam pipe connection to each radiator from which the air is withdrawn through a Monash air valve into a vacuum maintained by the vacuum pump. This suction line leads through a condenser which condenses any steam drawn through the air valves.

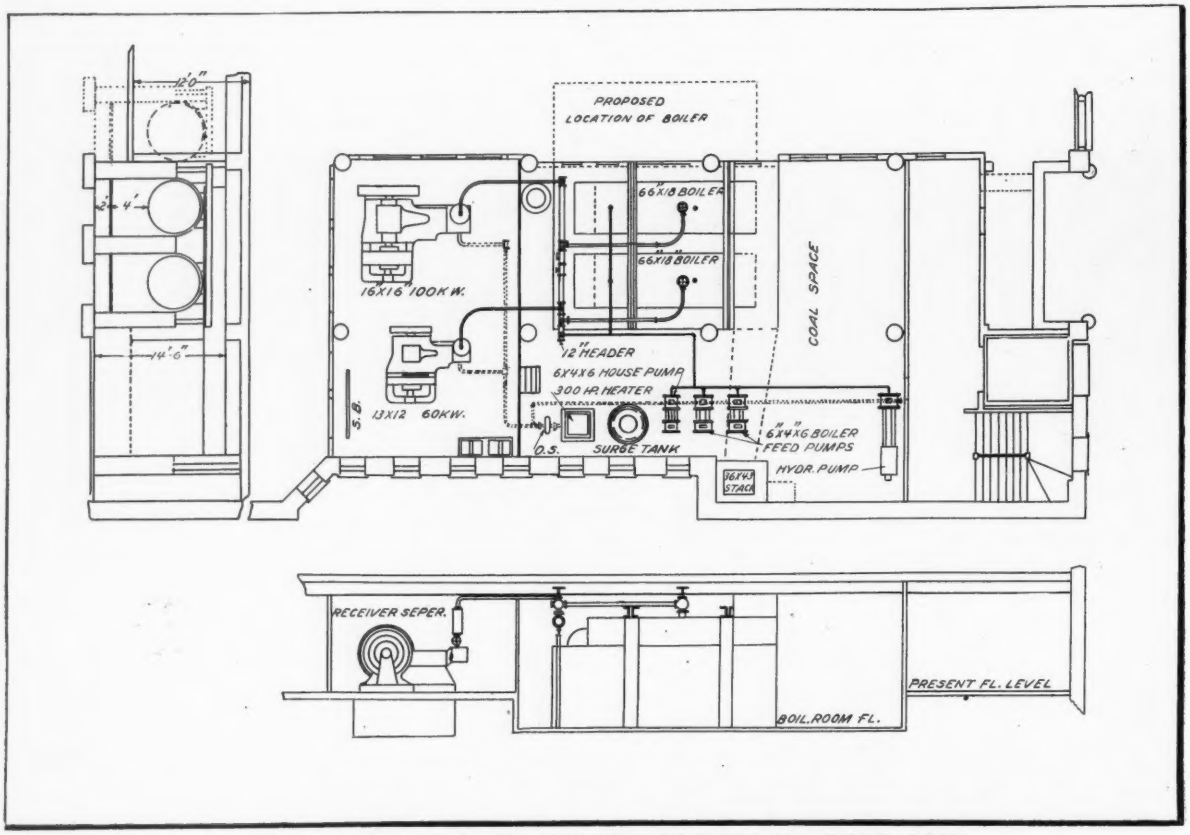


FIG. 2. GENERAL PLAN AND ELEVATIONS OF ENGINE AND BOILER ROOMS

The exhaust is carried away from the engines by a 9-in. pipe laid in a concrete trough beneath the engine room floor, covered by iron plates. This pipe leads to a Webster open feed-water heater, first passing through a John Davis oil separator and having a connection to the exhaust heating system. A G. M. Davis atmospheric relief valve is also located at this juncture. From the heater the feed water enters the boilers

Engine Room Equipment

INSTALLED in the engine room are 2 Ridgeway generating units, the engines of which are of side crank construction, having slide valves of the single balanced type, with a splash system of lubrication, while oil is furnished the cylinders by a Hart forced feed oil pump. No. 1 unit has a capacity of 100 kw.

and a speed of 250 r.p.m., while unit No. 2 is of 60-kw. capacity, running at 275 r.p.m., the dynamos being of Thompson-Ryan make. In the acceptance test of the machines at the shops of the builders, a brake horsepower was delivered on slightly less than 29 lb. of steam per hour.

Direct current at 220 volts is delivered from a 4-panel switchboard made by Freeman Sweet & Co., on a 2-wire system. The power and lighting currents are metered to the various tenants, 2 cut out panels being situated on each floor for the lighting and power circuits respectively.

Both carbon-filament and tungsten lamps are used on the lighting circuit, the former being connected directly across the 220-volt circuit, while the latter are connected 2 in series, an arrangement which obviates the necessity of using a balancer set.

An addition to the building, upon which work is now in progress, will increase the floor space from 12,500 to 18,750 sq. ft. To care for this increased load on the plant, an additional boiler will be installed. The steam line to the new building will be carried up

FIG. 3. VIEW IN BOILER ROOM

to the sixth floor of the present structure and then across to the addition, distribution being made with the supply line running downward.

Cost of Operation

THE following summary of operating costs for one year answer any questions regarding the practicability of such a plant as the one described:

Fuel	$3004.58
Waste	15.00
Oil	45.00
Compound	40.00
Packing	10.00
Hauling Ash	100.00
Repairs—	
Boilers	130.00
Engines	5.00
Pumps	6.00
Salaries	1320.00
	$4675.58
Kilowatt output	110,300
Cost per kilowatt	$0.042

All of these items are charged to the switchboard so the additional service of heat and live steam for manufacturing purposes are secured without extra cost. Considering the fact that on an average 50 per cent

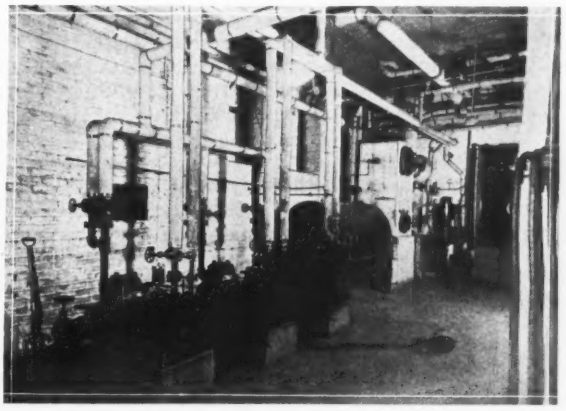


FIG. 4. BOILER FEED PUMPS SHOWING CONNECTIONS, ALSO FEED WATER HEATER AND SURGE TANK

of the load of the plant is a live steam load, the expenditure of 4.2 cents per kilowatt of output makes a very creditable showing.

PREVENTION OF DUSTING CONCRETE FLOORS

By Albert Moyer

CEMENT floors, particularly in buildings or warehouses, which do not have the advantage of obtaining the necessary moisture from the atmosphere as do outside floors and sidewalks on which the dew falls at night, if not properly protected and kept damp, become prematurely dry and are therefore more or less porous and weak, causing easy abrasion under foot traffic, or what is commonly known as dusting.

Wash the floor thoroughly with clean water, scrubbing with a stiff broom or scrubbing brush, removing all dirt and loose particles. Allow the surface to dry; as soon as dry, apply a solution of one part waterglass (sodium silicate) of 40 deg. Beaume, and 3 to 4 parts of water, the proportion of water depending upon the porosity of the concrete. The denser the concrete the weaker the solution required. Stir well, and apply this mixture with a brush (a large whitewash brush with long handle will be found the most economical). Do not mix a greater quantity than you can use in an hour.

If this solution is sufficiently thin, it will penetrate the pores of the concrete. Allow the concrete surface thus treated to dry. As soon as dry, wash off with clean water, using a mop. Again allow the surface to dry and apply the solution as before. Allow to dry and again wash off with clean water, using a mop. As soon as the surface is again dry, apply the solution as before. If the third coat does not flush to the surface apply another coat as above.

The sodium silicate which remains on the surface, not having come in contact with the other alkalies in the concrete, is readily soluble in water and can therefore be easily washed off, thus evening up the color and texture of the floor. That which has penetrated into the pores, having come in contact with the other alkalies in the concrete, has formed into an insoluble and very hard material, hardening the surface, preventing dusting and adding materially to the wearing value of the floor.

POPPET-VALVE STEAM ENGINE

By C. Van Langendonck

THE Belgian Walschaerts' Engine Works has recently introduced a new form of steam-engine, in which the 4 poppet valves on each cylinder are placed with their center-lines at an angle of about 30 deg. with that of the piston, which is beveled to fit closely to the inside face of the poppets in such a way that in working, the clearance between them is reduced to about 0.5 of one per cent. of the steam volume swept by the piston at each stroke.

Figure 1 shows some details of the new engine. In Fig. 2, it will be seen that the steam or admission valve, is single-seated, while its cylindrical part is fitted with rings, which render steam-tight the inside periphery of the valve between the steam chest and the extremity of the valve liner. The wear of these segments is said to be very slight, contrary to the case with piston valves, which, in traversing the ports, are subject to grooving effects from the bridges which carry them. The end of the valve chest liner forms the single seating for the valve, and is held up by the end of the valve chest, which in turn is secured by the bolted valve-chest cover.

By means of the single-beat valve a more perfect closing is realized, by avoiding the well-known practical difficulties experienced with double-seated valves. For the exhaust a different form of the valve is introduced without the rings for condensing or compound engines; or the valve in the other cases is single-seated and nonbalanced.

This absence of balancing is possible in view of the fact that during the admission, with the exhaust valve resting on its seat, the mechanism for the latter is subject to no stress. At the end of the expansion, just when the exhaust valve is about to open, the pressure in the cylinder rarely exceeds 14 lb. above the exhaust pressure, and this is sufficiently low to overcome with ease the resulting effort against the valve mechanism. In other cases it is preferable to balance the valve, otherwise at such moments, if the spring is not very long, the valve may rise and chatter on its seat. Further, when the apparatus run by the engine is subject to sudden intermittent demands for power, the governor swerves under the change, so causing admissions up to 50 per cent, provoking excessive terminal pressures and undue stress on the exhaust valves, etc.

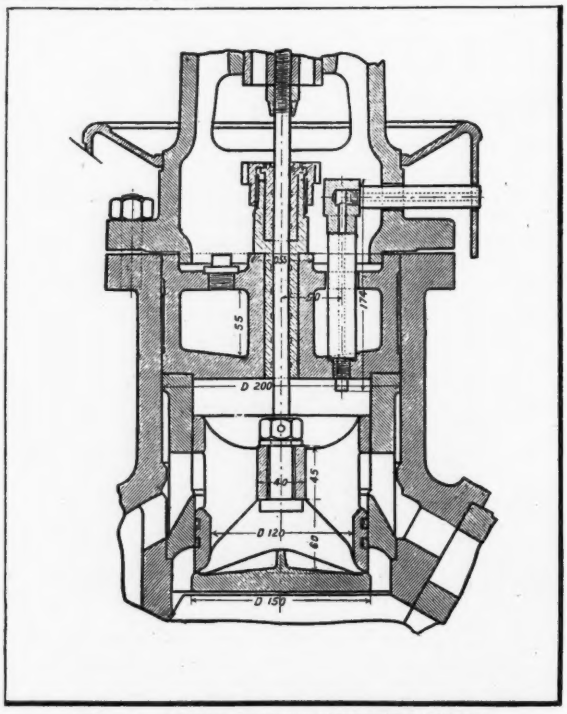


FIG. 2. POPPET STEAM ADMISSION VALVE

To meet these cases, the Walschaerts' engine is fitted with a single-seated exhaust valve which can be balanced at will. The arrangement consists of a disk, fitted with rings cast in one with the valve disk proper, as seen in Fig. 3. To balance the single-beat valve shown it is obvious that the admission of steam from the exhaust cavity to the back of the piston valve equalizes the pressure on the 2 opposite faces. This

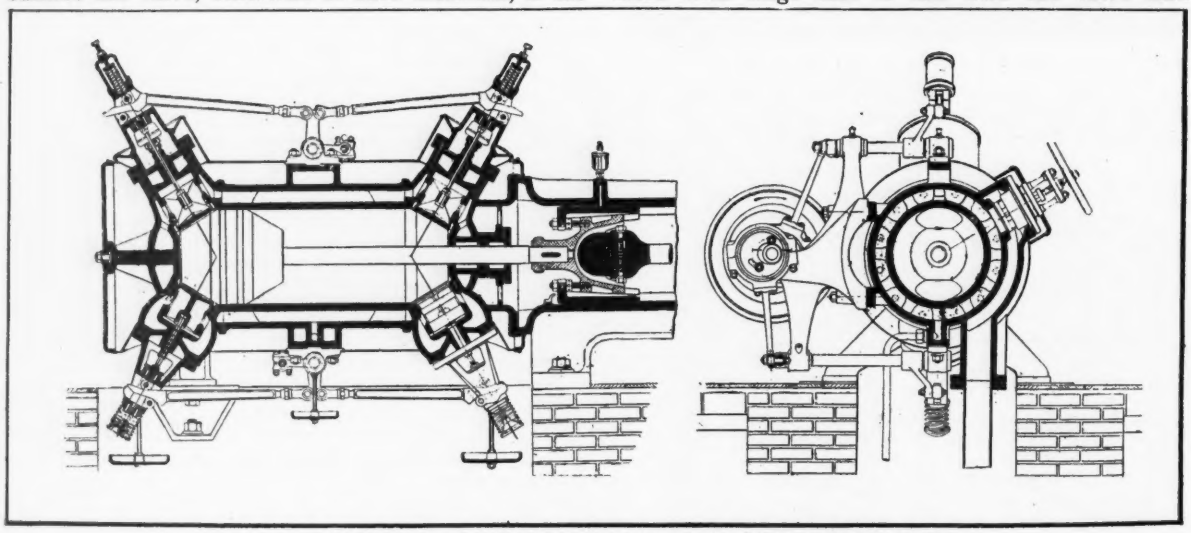


FIG. I. CYLINDER OF HORIZONTAL STEAM ENGINE WITH POPPET VALVES

connection is made by means of the small steam way shown in the steam-chest liner ending behind the valve in a 2-way cock, which opens to a pipe either leading outside the cylinder or to the space behind the piston valve. A quarter turn of the cock suffices to obtain balanced or nonbalanced working of the valve.

As Fig. 1 shows, the entire cylinder is effectively steam jacketed by the admission steam, and an endeavor is made to heat the disk of the valve, forming as it does an effective portion of the cylinder wall's interior surface. The valve is cast with an interior cavity into which steam is admitted by a small inverted valve held up by a spring and working similarly to an anti-vacuum valve. During steam admission to the cylinder the valvette yields to the pressure, and admits high-pressure steam into the cavity of the single-beat valve. After cut-off the pressure inside

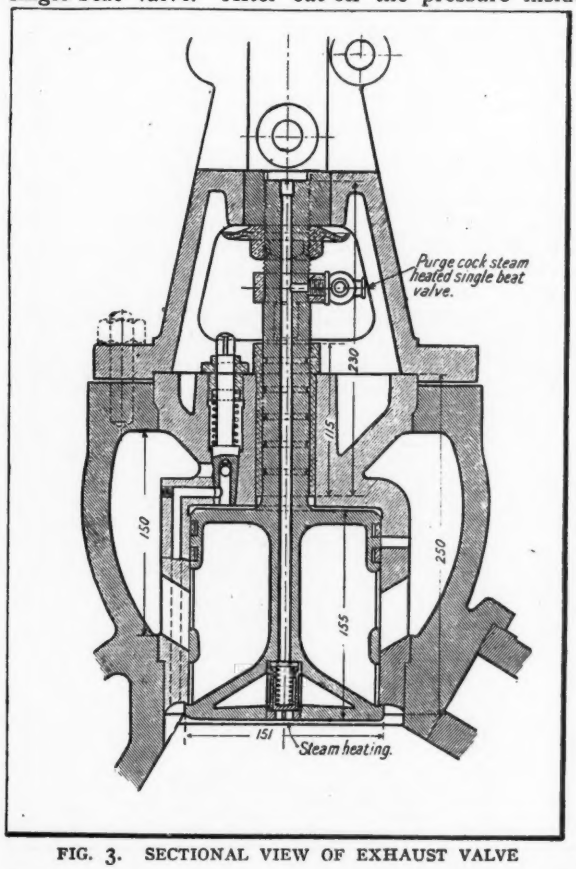


FIG. 3. SECTIONAL VIEW OF EXHAUST VALVE

the valve automatically closes the valvette against the lesser pressure in the cylinder, so enclosing steam of the pressure of admission. Provision is made for the escape of a very small amount of condensation water precipitated in the disk valve by means of a perforation in the center of the valve spindle itself, a little cock here allowing the beads of water to escape as fast as they form in the cavity.

The operation of the poppets is effected by a modification of the usual trip-gear mechanism, the cams of suitable profile transmitting the time movements through rollers to the valve stems. The driving gear for the oscillating rods carrying the admission cams is derived from an eccentric whose throw and angle are variable by means of the new Walschaerts-Recke system of governor.

UNIFORM GAGE REQUIRED

By C. L. Herrick

ONE thing which would benefit engineers in general would be the establishment of a standard gage for all measurements. The 10 different gages now existent are indirectly responsible for a great many losses and misunderstandings between purchasers and sellers.

This subject was given a great deal of discussion at a recent meeting of a society of engineers. The facts emphasized were that the various wire and sheet metal gages in common use are:

1. Often inaccurate as made.
2. Becoming inaccurate as made.
3. Confusing on account of too many standards.
4. Difficult to calibrate.
5. Cost nearly, if not as much as micrometers.

The establishment of one standard uniform gage would cost less to engineers, and would eliminate a great deal of the uncertainties and worries of the average man in regard to the accuracy of his measurements.

1. American or so-called Brown & Sharpe is used for sheet brass, sheet aluminum, sheet German Silver, brazed brass tubing, brass, copper, and German Silver wire.

2. United States Standard gage is used in determining duties and taxes levied on sheet and plate iron and steel, is also used by some rolling mills for same purpose. Also used for galvanizing sheet iron and planished iron.

3. The Birmingham or stubs or English Standard Iron gage is used for sheet iron, sheet steel, sheet copper, iron wire, bessemer steel wire, and seamless tubing of all kinds.

4. The Washburn & Moen and Roebling's gage is not much used except by themselves.

5. The Illinois Zinc Co.'s gage is used on their own products of sheet zinc, and nickeloid.

6. The Russia iron gage applies only to the imported Russia iron.

7. The Stubs, music wire gage is used for hard drawn steel wire, namely, piano wire.

8. The Stubs special steel wire gage is used for tool steel wire commonly called drill rods, also by some for toll steel wire in coils and spools. This particular gage after running backward out of numbers commences on the alphabet and exhausts it in the endeavor to complicate the problem.

9. The twist drill gage, also used for drill rods and steel wire.

10. The American Screw gage is used for machine screws and wood screws made of iron, steel or brass.

Also others, viz.: British, Imperial, Edison circular mil, etc., but, in my opinion, the best of all except the micrometer is the decimal gage, running from 2 to 250 thousandths.

Table shows variations in different standards:

	No. 1	No. 10	No. 20
American or B. & S.	.289	.102	.032
U. S. Standards	.281	.141	.038
Birmingham or Eng. Stand.	.3	.134	.035
Washburn & Moen	.283	.135	.035
Illinois Zinc Co.'s	.002	.02	.07
Stubs Music Wire	.016	.027	.043
Stubs Special Steel Wire	.227	.191	.161
Twist Drill (Morse Co.)	.228	.194	.161
American Screw	.071	.189	.321

THE RITES GOVERNOR*

Sketch of Improvements in Designs, Use of Inertia and Centrifugal Weights, Overcoming Effects of Friction and Equalizing Cutoff

By Sterling H. Bunnell

IN 1894, patent 527,720 was issued to Mr. Rites for a 2-weight governor of markedly peculiar form. The weights were not at all alike in location or action. In the light of present information, it is easy to see that the shorter weight, if shifted and made to coincide as to pivot with the longer weight, would give rise to the Rites governor as we know it. There is no very long gap between this governor and the step by which the 2 weights are brought together into one.

In the specifications and claims of this patent, Mr. Rites introduces a dash pot and connection between one weight, which corresponds to the long arm of the standard Rites governor, and the other weight, which corresponds to the shorter arm. The intention is clearly to make use of the centrifugal force of the long arm to regulate the engine as to revolution speed, and to superpose inertia force of the other arm to quicken the action of the first when the engine changes its speed under the influence of a change in load.

Following this "near Rites" governor, we find Patent 534,579 of 1895, with a series of illustrations of grotesque forms of governor arms, each, however, taking a definite shape to demonstrate some definite force or combination of forces. By a series of logical steps, successive governors are developed with the central idea of a primary weight acting centrifugally and a secondary weight acting by inertia effect.

It is easy to conceive the 2 weights joined into one, and when this is done the governor begins to take shape as the Rites governor which we well know. Figure 4B shows the weight of the previous A turned into a new position, but evidently having all the various actions of the weight as first shown. The exact shape of the weight is evidently not essential, as the principle of action is unchanged. Figure 4C shows a wheel-shaped governor weight, which is further developed by 2 other figures not shown here. The governor has now taken definite shape as a single-weight governor, and would be recognizable anywhere as of the Rites design.

The next patent of Mr. Rites, 582,231 of May, 1897, deals with a 2-weight governor, one of the weights serving for inertia effect and the other for centrifugal effect. This seems like a retrograding period in the development of the governor. The patent embodies, however, an interesting application of an unbalanced governor to a vertical engine, so that the weight of the valve gear counteracts the disturbing effect of gravity upon the governor weights. This feature has very useful application in connection with the standard Rites governor as used with vertical engines.

It has already been shown that a horizontal engine governor can be balanced as to gravity by a spring or a piston tending to lift the governor weight or eccentric; or by the unbalanced pressure on the valve rod

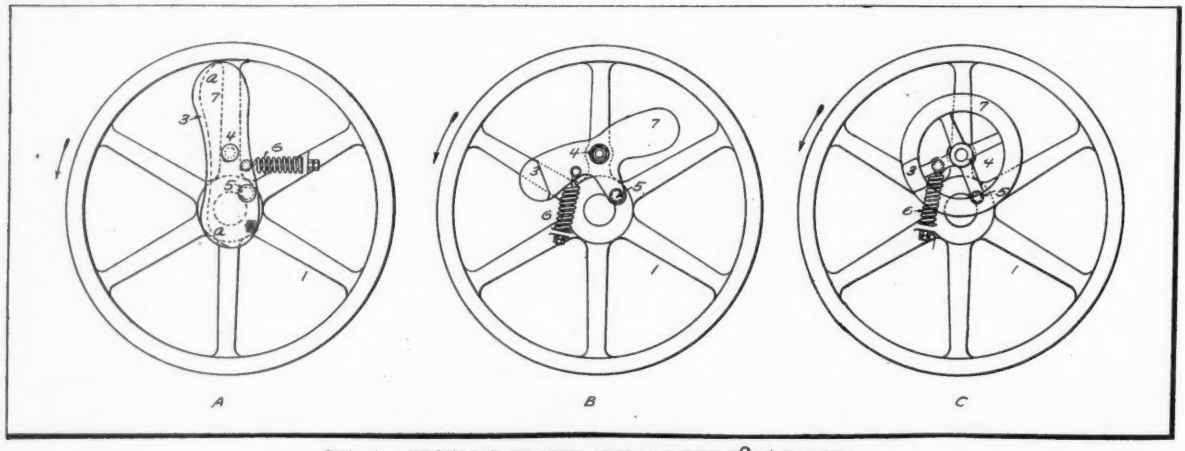


FIG. 4. PECULIAR SHAPED ARMS OF THE 1895 PATENT

In Fig. 4A there are 2 governor weights hung on the same pin 4. One is bounded on the left by dotted line a-a. This weight is evidently in balance centrifugally, and does not tend to turn about its central pivot point under any influence except that of inertia. A change in speed of the governor wheel will cause a change in position of the weight, since the outer end of the weight is subject to the influence of a change in velocity. The other weight extends beyond the dotted line a-a, and is therefore unbalanced as to centrifugal force. Increase in speed of the wheel will tend to make the centrifugal weight turn to the right relatively to the wheel, compressing the spring accordingly.

due to the steam pressure in the valve chest. This action is located 90 deg. from its proper position in the case of a vertical engine. Mr. Rites, however, overcomes the difficulty by the simple means of interposing a rocker and changing the angle of the force accordingly. The illustrations in connection with this patent show 2-weight governors in every case; but the illustrations of the vertical engine show a piston-balance and a spring-balance, as well as the transfer of the forces of gravity through the rocker arm.

Like all shaft governors, the governor of Mr. Rites could not be altered in adjustment to change the speed of the engine during operation; and this problem next engaged his attention, as shown by his solution in patent 582,233 of May 1897. Taking advantage of the

*Continued from Page 363 of Practical Engineer for April 1.

fact that increasing the friction of the valve gear, or opposing resistance to its free motion, tends to speed up the engine (having the same effect upon the governor as tightening the spring), Mr. Rites applied a solenoid which could be operated electrically from a switchboard so as to oppose a variable resistance to the motion of the valve gear.

By this means the engineer at the switchboard could increase or decrease the speed of the engine through a reasonable range while it was in operation; a feature of great importance in starting alternators in parallel, as well as for other purposes. The same effect can be produced by interposing a dash pot, and this construction is also shown in connection with the patent.

Balancing Valve Friction

PATENT 646,237 of March 1900, shows a digression from the single rigid weight which has become standard with Rites' governors. The illustrations and claims of this patent cover a flexible governor arm, in which the spring is connected to a weight which acts centrifugally as well as through the spring.

It is not clear that this form of governor has any desirable field of application in comparison with the simpler type as it has become standard; yet this patent was followed by others—646,314 and 646,315 of March 1900, along similar lines. The last mentioned patent, however, shows a drag for spring friction in connection with the governor, a device which in many cases has proved of great use, particularly where engines

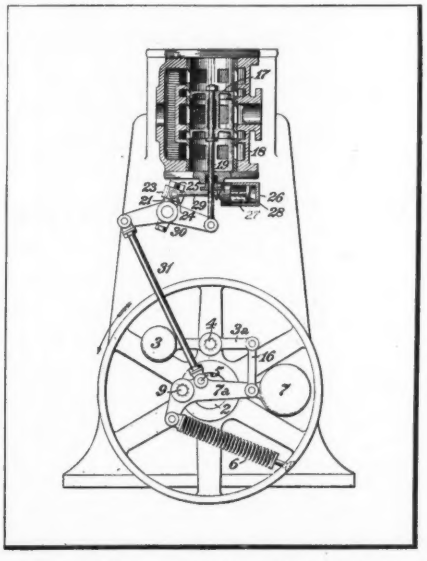


FIG. 5. TWO-WEIGHT GOVERNOR FOR VERTICAL ENGINES

are operated at slow speed. Both of these patents show various forms of rolling weights, but all of them can in effect be replaced by pivots or similar mechanism.

Patent 651,953, of 1900, recalls the first patent mentioned above, in that it embodies features for balancing a single weight governor in connection with a horizontal engine, by means of the unbalanced pressure on the valve stem, or an interposed spring in connection with the valve gear. The difference, however, is that in this last patent Mr. Rites has discovered the possibility of changing his single governor weight through an angle of 90 deg. with respect to the eccentric, and thereby opposing the unbalanced pressure on the valve stem as a counterweight against the effect of gravity on the governor arm.

During the portion of revolution where the governor arms tend to fall forward, the unbalanced pressure on the valve stem tends to push the eccentric pin so as to force the governor arm backward, and vice-versa during the other half of the revolution. This feature has been of great advantage in connection with the design of Rites' governors for moderate-speed horizontal engines.

Patent 687,504 of November 1901, shows another modification of the single-weight Rites governor, in which a separate eccentric has been added and linked to the governor arm so as to neutralize the effect of gravity. This idea has been adapted into the balanced Rites governor used on slow and moderate-speed engines. The path of the eccentric pin in this con-

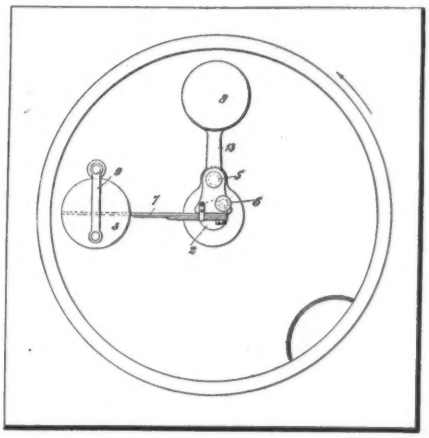


FIG. 6. TWO-WEIGHT DESIGN WITH ONE WEIGHT CARRIED ON LEAF SPRING ARM

struction may be very different from the path of the eccentric pin of the standard Rites governor with its increasing lead at later cutoffs.

As it is essential that the valve shall not open when the governor is in its extreme outward, or full-speed, light-load position, it is necessary in setting a Rites governor of usual type to give the valve sufficient lead to afford satisfactory steam distribution under the usual working load, and no lead in the full-speed or zero cutoff position. As a result, the lead of the standard Rites governor at greatest possible cutoff is excessive.

The patents above cited and illustrated cover the Rites governor as it is now used. Others have been issued to Mr. Rites for reversing governors, and for the application of the Rites governor to internal-combustion engines; but these are of little interest to the designer and user of the Rites governor for high-speed steam engine control.

The progress of the Rites governor, as its form was successively developed and simplified by Mr. Rites, applied to steam engines of various makes, and gradually worked down toward the present efficient design, is of great interest. At first, the question was, what to leave off; then, how to do without the omitted parts without disturbing the operation of the governor. It was a bold stroke to throw away all balancing devices and produce a governor consisting of a single arm of great weight, hung near the center, and restrained by a single spring.

Effect of Adjustments

SMOOTH action of the Rites governor depends upon the balance between several different and dissociated forces. If this balance is disturbed, the governor becomes quite unmanageable. Remarkable "stunts" may be performed by a governor of successful and standard design when set up with an unusual spring, and particularly with conditions artifically altered by the master hand of Mr. Rites himself.

For instance, a governor designed for operating at 300 r.p.m. can be run with a light spring intended for a governor of ¼ the weight, and when properly adjusted will behave as well as could be desired. But slight changes in the spring tension will make such a governor bump wildly against the stops, or run the engine fast, then slow, in regular waves of movement, or perform irregular antics without any apparent period or rule. Pivot friction is an important force in the combination which makes the Rites governor stable.

Pivot Pin Friction

DESIGNERS, and more particularly, some consulting engineers, have put forth efforts to make frictionless governor pivots, with the idea that pivot friction is detrimental to sensitive action. Every such attempt has resulted in an unsatisfactory governor. The early Rites governors were made, in some cases, with small pins unsuited to the strain of the heavy arm, and these pins were naturally made larger in later designs. How much of the improved action of the governor is due to the greater strength of the large pin, and how much rather to the increased friction thus introduced, is a question. Mr. Rites has said to the writer that more than one governor pivot has been fitted too smoothly and too easily to work satisfactorily. After pivots have been made frictionless at great expense, drags of various forms are often required to restrain governor arms which refuse to maintain their positions.

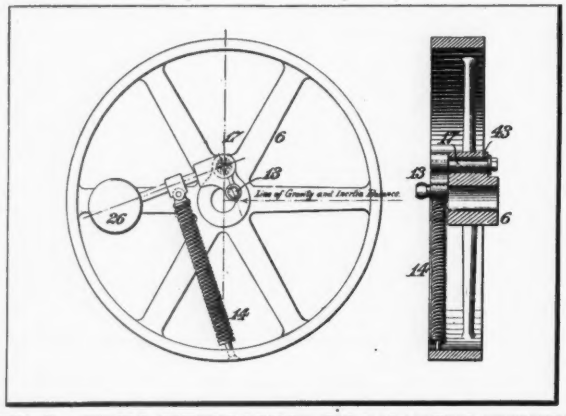


FIG. 7. SINGLE-WEIGHT DESIGN FOR BALANCING PRESSURE ON VALVE STEM

Equalizing Cutoff

ONE thing little noticed in connection with the Rites governor is its effect when slightly out of balance, in equalizing the cutoff between the 2 ends of the cylinder of a single-valve engine. With the steam valve taking steam on its outside edges as usual, and the governor connected in the usual way, the slight movement of the arm as it falls forward during half the revolution of the engine and falls backward during the other half of the revolution is just what is required to lengthen the cutoff on the crank end of the cylinder and shorten it on the head end.

Indicator cards taken from such engines show a remarkable equality of cutoff, which cannot be produced with any fixed eccentric. On the other hand, if such engines are made with valves taking steam on the inside edge, the movement of the governor distorts the cutoffs, so as to make them more unequal than could be caused by the effect of the connecting rod length. This is one of the remarkable advantages of the Rites governor, which was possibly not understood or expected when the governor was brought out.

Out of long experience with the numerous and obscure forces which give the Rites governor its peculiar efficiency, Mr. Rites has developed an extremely simple set of formulas and rules for use in designing governors. These rules are the result of a brilliant analysis of the dimensions and figures of successfully-working governors. Their application is so simple and satisfactory that the success of any Rites governor may be considered assured in advance of its construction.

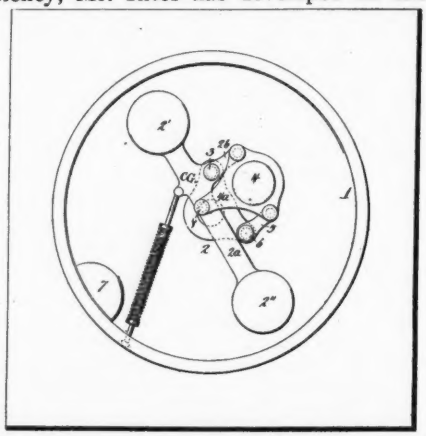


FIG. 8. SINGLE-WEIGHT GOVERNOR OF NOV., 1901

NOVEL ABSORPTION DYNAMOMETER

SINCE the introduction of electric power for driving machinery, cases have frequently arisen where speed reduction was necessary for transmitting power from the shaft of the motor. This is generally accomplished by a countershaft and gearing. The efficiency of gear transmission is important when determining what type should be adopted. The problem of how to measure the horsepower output of the gear in a definite and accurate fashion is sometimes troublesome. It is obvious that the best way of doing this in an ordinary workshop is to use a prony brake, but owing to the large powers which frequently have to be transmitted such a brake would in some instances have to be made especially for a particular test. Experience has shown that the construction of such a large brake is hardly warranted for the number of times it would be used.

Details of a method adopted in a general engineering works for accurately testing gear drive will be of interest. A large triplex hydraulic pump was fixed temporarily near the works' sump and the suction pipes carefully jointed. A large screw down valve was placed on the delivery side of the pump, which communicated with the delivery pipe. The pipe was run to the mouth of the sump, but the delivery outlet was kept well above the surface of the water. An ordinary pressure gage was attached to the pump side of the valve and a tachometer was arranged to register

the revolutions of the pump crank shaft. When this had been done the gear to be tested with an electric motor coupled to it was attached to the high speed pump shaft. An ammeter and voltmeter in the electric circuit completed the equipment.

When everything was ready, the motor, gear and pump were run up to speed with the delivery valve on the pump wide open. The valve was then gradually screwed down and load was applied to the gear in this way by throttling the delivery or creating an artificial head.

The reason for this method of coupling the gear and its application to efficiency testing will be seen from the following formula:

$$\text{Hp.} = \frac{\text{PLAN}}{33{,}000} \quad \text{where}$$

P = Pressure due to the head of water, in this case the gage pressure indicated on the pump.
L = Length of pump stroke in feet.
A = Area of one pump plunger in inches.
N = Total number of strokes of the pump per minute.

This is, of course, a standard formula and needs no proof here. It will be seen that L and A are constants in the formula for any particular pump used, hence the formula under the conditions given can be simplified to the expression Hp. = K P N, where K is a constant depending on the dimensions of the pump.

In this case the motor was a direct-current shunt-wound machine; therefore when working with its rated capacity the speed was approximately constant. In order, however, to secure accuracy, the tachometer readings were taken from which the value N was determined.

The test outlined is subject to one or two corrections which need to be mentioned before the method can be accepted as accurate. The corrections vary in importance according to local conditions under which such a test is applied. In the first place there is the question of leakage of water past the plungers. This does not affect the accuracy provided it is not sufficient to affect suction. There is, however, a back head due to the suction column and there are also the pump losses themselves to be considered. The power absorbed was found by taking volt and ampere readings with the delivery valve wide open. The pump was disconnected from the gear and fresh watt readings were taken; the difference between the 2 readings obviously gives the power loss in the pump. This difference of horsepower would, of course, be deducted from the value of horsepower at which the efficiency of the transmission gear is tested. The delivery valve would be screwed down to give the gage pressure corresponding to the horsepower obtained.

For example, assume that the efficiency of the gear had to be determined at an output of 10 hp., and that the power absorbed by the pump losses is 1 hp., then the valve on the delivery has to be screwed down until the horsepower determined by the formula $\frac{\text{PLAN}}{33{,}000} = 10 - 1 = 9$ hp.

There is also the question of motor efficiency, which of course, affects the watt readings on the supply side of the motor with reference to the power actually delivered by the motor to the gear. In this case the gear efficiency had only to be guaranteed at full load, and therefore a certificate of full load efficiency was obtained from the electrical manufacturer and taken as a basis of acceptance by the buyers of the electrically-driven machine and gear.

The sump used was of fairly large capacity and therefore it was found possible to run the test. The arrangement described ran on full load for some time without undue heating of the water passing through the restricted passage of the valve. If the sump were small it would probably be found that owing to the friction of the passages through the valve, the water would gradually get hot and the readings would then become erratic. As it was, the test results obtained were very steady, and when the method had been explained to the buyers of the machine they were well satisfied with the measures taken.

A CONTRARY FAN

By William E. Dixon

GUS is a switchboard man in a central station. In the first part of his watch Gus has a snap; but after 6 o'clock, when the big office downtown closes, all "trouble" comes to Gus and then indeed his troubles begin. Some of them are perennial, some are seasonal. It is about the latter sort that this story hinges.

Last spring it was vacuum cleaners. An employee of the big music school in the city, when no one was looking, sneaked out the side door with the institution's suction broom, brought it home and started to clean house. But, as with some other wicked ones, his sins seemed to have found him out. The thing wouldn't go at all—just sit there and buzz and sing in an irritating sort of way. So he confided in Gus. The latter happened to know that the school plant was d.c. so he broke the sad news gently.

When the hot wave struck us in early summer, the fan became the prime source of trouble. Several people brought d.c. fans at city stores, and, unable to use them, turned to Gus for help. Men from the offices of the city railway lugged fans home, only to learn that they had had "their trouble for their pains."

One sweltering evening a man appeared at the door lugging a big fan. Gus knew him and knew that he ought to know better, so determined to teach him a lasting lesson. It was the same old story. Had brought it home from the office—worked all right there, but couldn't start it at home—maybe something jarred loose. Gus was sympathetic, got a searchlight and inspected the thing carefully. Finally he announced that he could find no trouble, and believed the thing ought to run all right. To prove it he stepped over to the battery charging set, picked up a pair of d.c. leads and applied them to the plug attached to the fan. Away went the fan at a merry pace.

"Well, well," ejaculated the pleased traveler, "why couldn't I do that?"

"Perhaps," suggested Gus, "you didn't screw the plug clear into the socket. I don't see anything the matter with the fan."

"Nor I, either," agreed the victim as he took up his fan and walked.

But the end was not yet. A half hour later he returned again with that fan. More parley, more proof with the leads from the battery charging set, and again he set out homeward convinced that the fan ought to run all right.

He didn't come back; but two weeks later Gus met him at Revere Beach. Of course Gus was solicitous about the fan.

"Darn you and the fan," was the reply. "I tumbled, finally. I'll square up with you some day."

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

PIEDMONT TRACTION COMPANY'S PLANTS

Highest Direct-Current Voltage Ever Used in This Country for Electric Traction; Description of Sub-Station Apparatus

EQUIPMENT THAT WAS RECENTLY placed in service by the Piedmont Traction Company, which has commenced the operation of an extensive electric railway system in North and South Carolina, is of particular interest because the voltage of 1500 is the highest direct-current pressure ever used in this country for electric traction.

The property is also of interest because the energy is not generated by the Piedmont Traction Company, but is supplied from the Southern Power Company's lines through nine sub-stations to be located respectively at Charlotte, Gastonia, King's Mountain, Spartanburg, Greers, Greenville, Belten, Anderson and Greenwood. As far as possible duplicate equipment is used in all of the stations. The 1500 volt direct current is obtained by connecting 2 750 volt direct-current generators in series. All of the equipment is Westinghouse.

Motor Generator Sets

MOTOR generator sets are exact duplicates and each consists of two 250 kw., 750 volt, direct-current, compound-wound generators driven by a 750 hp. synchronous motor. A 6½ kw., 125 volt, direct-current exciter for the synchronous motor is mounted at the end of the shaft. Two 500 kw., direct-current units have been installed in the Charlotte sub-station, one at Gastonia, 2 at Dead Falls, 2 at Greenville, 2 at Belton, a special one at Anderson and one at Spartanburg. A typical sub-station building is shown in Fig. 1.

Equipment of Sub-stations

ENERGY is taken at the Dead Falls station from a 13,000-volt line, and at Belton from a 44,000-volt line which is fed through step up transformers from a 2200-volt line at the Greenville sub-station. In all of the other sub-stations energy is taken directly from the 2200-volt lines and in every case the voltage on the motors is 2200.

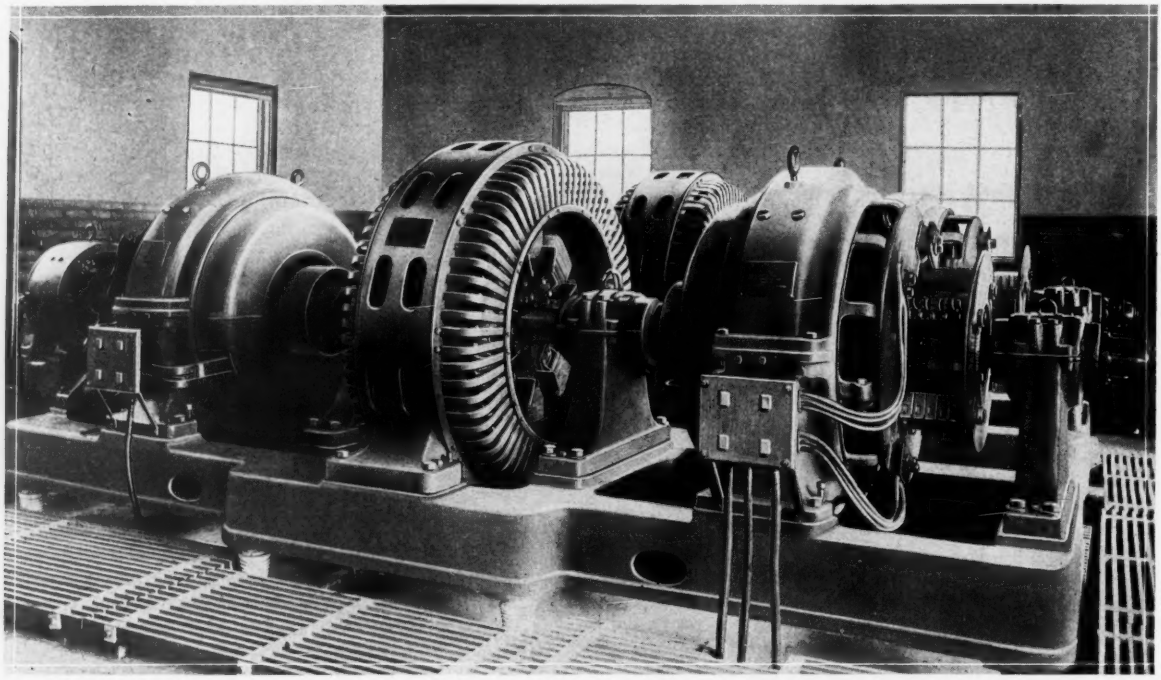


FIG. 4. SIDE VIEW OF ONE OF THE 1500-VOLT MOTOR-GENERATORS

In all of the sub-stations the switchboard equipment is similar. The schematic diagram of Fig. 2, and the view of the switchboard, Fig. 3, are typical of all the sub-stations. The panels are of black marine finished marble.

An interesting feature is that the circuit-breakers and knife switches on the 1500-volt circuits are arranged for remote hand control. Danger of accidents

from high voltage flashes is therefore eliminated. In some of the stations a TA voltage regulator has been installed for maintaining the alternating-current volt-

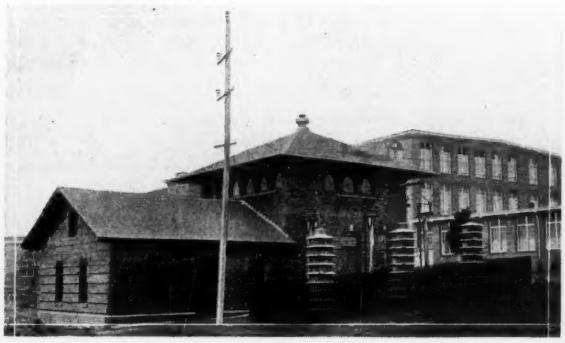


FIG. 1. EXTERIOR VIEW OF A TYPICAL SUBSTATION

age approximately constant. It does this by acting on the exciter fields and varying the field excitation of the synchronous motor. Feeders to the trolley cir-

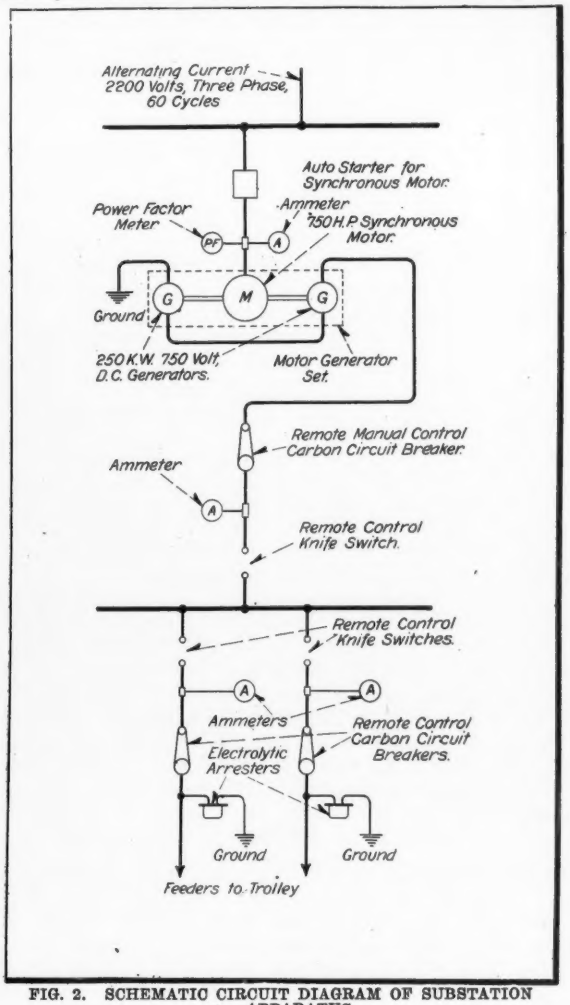


FIG. 2. SCHEMATIC CIRCUIT DIAGRAM OF SUBSTATION APPARATUS

cuits are protected by Westinghouse electrolytic lightning arresters.

The auto starter, which reduces the voltage for staring the synchronous motor, is shown back of the switchboard in Fig. 3, which also illustrates the methods of supporting the direct-current and alternat-

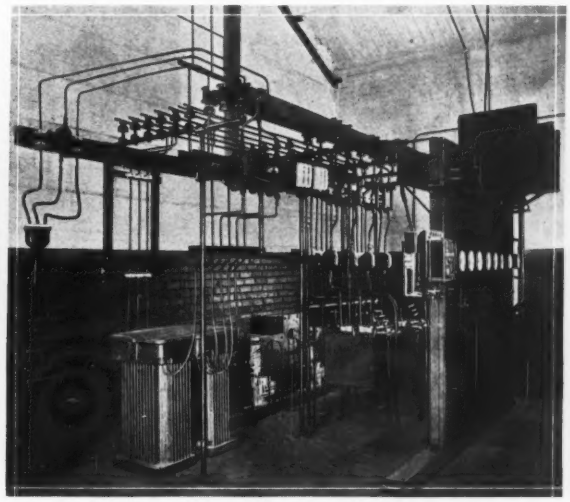


FIG. 3. VIEW OF 1500-VOLT SWITCHBOARD

ing current bus bars. The voltage regulator is shown mounted at the left end of the board.

COMMUTATION IN DIRECT CURRANT MOTORS

Why Shifting of the Brushes Is Necessary When Commutating Poles Are Not Used

ARMATURE current sets up a magnetomotive force in the core which opposes the field magnetomotive force, the resultant of these two forces causing the flux to be shifted, decreasing the density at the leading pole tips and increasing it at the trailing pole tips. This phenomenon is known as armature reaction and is proportional to the armature current.

As the field flux is shifted backward in a direction opposite to that in which the armature rotates the brushes have to be given a backward lead to obtain a field for sparkless commutation, as will be explained later. This sets up two components in the armature known as cross ampere-turns and back ampere-turns.

To more fully illustrate these two components, refer to Fig. 1, where the light and dark circles about the periphery of the armature represent the conductors, and the line A the theoretical neutral line. The current is assumed to be directed away from the observer in the conductors represented by the dark circles and toward the observer in the light circles, magnetizing the core and setting up a magnetomotive force in the direction of the arrow heads on the dotted lines. If the current should be reversed in the armature shown in Fig. 1, the magnetomotive force would assume a direction opposite to that indicated.

The phenomenon explained in connection with Fig. 1 illustrates the action of the cross ampere-turns whose magnetomotive force acts at right angles to the field magnetomotive force. When a backward lead is given to the brushes, the neutral lines are also shifted. Under this condition of operation, the armature conductors included in the space between the poles form the other component or back ampere-turns which directly oppose the field magnetomtive force. The effect

of the two components is to distort or shift the path of the field flux as already explained.

To consider more fully the effects of this armature reaction, refer to Fig. 2, which is a diagramatic representation of the armature winding. It will be seen that the electricity enters the positive brushes (only one of which is shown), divides and leaves at the nega-

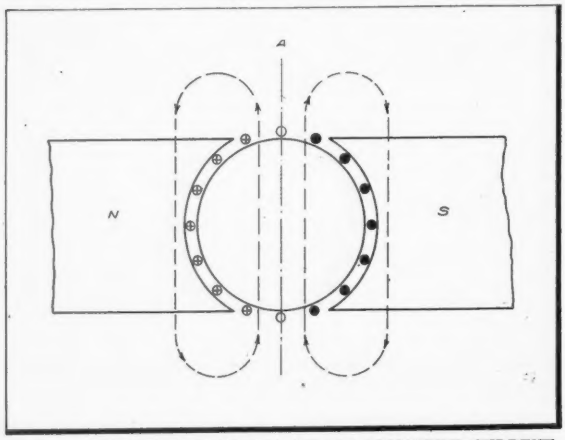


FIG. 1. MAGNETIC FLUX SET UP BY ARMATURE CURRENT

tive brushes. It is also apparent that as each coil passes under the brushes it is short-circuited as shown in the figure and when leaving the brush the current through the coil is in the direction opposite to that when the coil is approaching the brushes. The backward lead of the brushes brings the short-circuited coils under the influence of the field flux so that an electromotive force is generated in them in the same

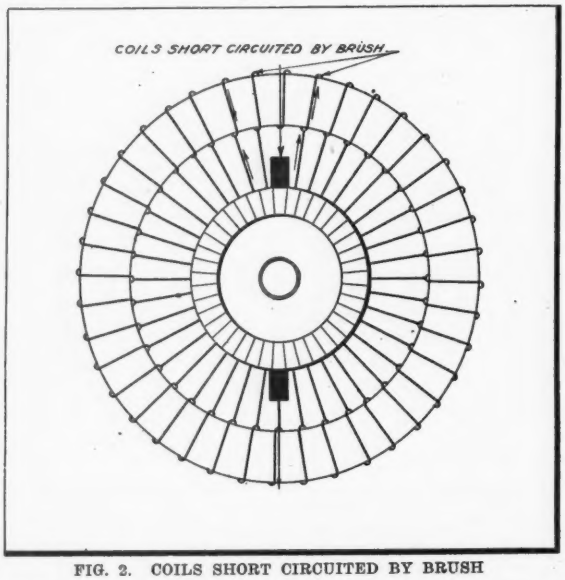


FIG. 2. COILS SHORT CIRCUITED BY BRUSH

direction that the impressed electromotive force will assume when the coils pass the brushes. If no current were produced in the short circuited coils their inductance would cause an arc from the toe of the brush to the segment passing under it, resulting in serious sparking. This condition would be still more exaggerated if the brushes were given a forward lead, as an electromotive force would be generated in the short-circuitd coils that would directly oppose the impressed electromotive force as the coil passes from under the brush.

ELECTRIC VEHICLES

Practical Suggestions for Their Up-Keep and What to Do in Case of Trouble

OPERATION AND CARE OF AN ELECTRIC automobile is a simple matter if ordinary precautions are taken. Judgment in driving should be exercised and the vehicle should not be overloaded or driven at excessive speed. All of the parts should be kept clean and in proper adjustment, and the battery kept in good condition and properly charged. All nuts and bolts should be kept tight.

Controller

CONTROLLER cylinder under the seat is revolved by a handle projecting above the seat. Turning the controller changes the electrical connections of the motor and varies the speed of the vehicle, similar to an electric car controller.

In starting, time must be allowed to attain a certain speed before moving the controller to the next notch. The car should not be run longer than necessary on the first two notches, which include resistance in series with the motor.

Controller handle should not be kept in continuous motion, as it is not necessary and increases the wear and strain on all parts of the vehicle.

Main switch should always be opened and the brakes set before leaving the vehicle. By so doing the motor and bell are disconnected from the battery and the vehicle cannot start by itself. The controller shaft and all of the controller bearings should be oiled occasionally. The surfaces of the controller segments must be kept bright and clean by the use of fine sandpaper. A small amount of vaseline may be used on them to maintain a good surface.

When working the controller, it is well to disconnect one side of the battery to prevent accidental short-circuiting. The controller fingers should give a fair pressure on the cylinder segments and bear evenly across their width. The fingers may be fitted to the segment by moving a strip of sandpaper between the segments and the finger, sanded side against the finger. Care should be taken not to sand so much surface that it will bridge across the gaps between the sections of a ring or segment, and thus make improper connection of different running points.

If the controller has adjusting screws for regulating the drop of the finger between the segments, the drop should be adjusted to about 3/32 inch. This is especially important on the last running point of the controller. It need not be considered on a controller having fibre bridges between the segments, where no drop is necessary. In all cases firm pressure and good contact should be maintained. Waste, tools and dirt should not be allowed to accumulate under the controller.

Motors

THE only parts of a motor needing attention are the commutator, brushes and bearings. Each moto should be inspected at least once a week and the commutator should be examined when the motor is running with the rear wheels jacked up, to detect any sparking which may be due to a dirty or worn commutator or a broken brush. The commutator may be lubricated slightly with a very little vaseline applied with a clean cloth while the motor is running.

The commutator in normal condition presents a smooth, brownish surface. If blackening appears after

operation it may be due to sparking or wearing. The remedy is easily applied when the trouble is located. If the brushes are too loose the tension of the brush springs should be increased. If the brushes are badly burned, worn down or make poor contact, they should be replaced with new brushes. They should be sandpapered to fit the commutator, which should also be smoothed, while running, with No. 1 or No. 2 sandpaper. Emery cloth should never be used. If the brushes are tight or are welded in the holder and do not work freely, either new brushes should be inserted or the old ones should be refitted. If the commutator becomes badly worn, or shows irregularity, it should be renewed or turned down to a smooth even surface in a lathe. If the commutator is slotted between the segments it should be reslotted after turning down, to remove any burrs from the segments.

If the commutator flashes, it may be caused by a broken lead which produces a greenish flame at the brushes and burning of the segment to which the broken lead is attached, and the segment adjacent to it. This burning should be stopped by placing a jumper over the segment at fault until a complete examination can be made and the broken connection permanently repaired. A flare at the commutator may be caused by a short-circuited field coil, which can be detected by testing the voltage drop in the coils by means of a volt meter.

Brakes

BRAKES should be examined every morning. The brake band is faced with leather, which must be renewed before wearing through. The brake toggle should never be adjusted so tight that less than one-eighth inch space shows between the brake shoe and the drum when the brake is in the "off" position. If the brake does not hold firmly and is found to be tight enough, it may be greasy or oily and should be washed out with gasoline.

Brakes should not be applied suddenly except in emergency, as a sudden stop may strip the tires or do other damage. A steady breaking pressure is usually possible.

Tires

TIRES should be watched to detect signs of looseness or other weakness. Prompt repairs of a slight nature will prolong the life of a tire. Grease or oil should not be allowed to remain on the tire, as it rots the rubber. Unnecessary exposure of the tires to extreme heat should be avoided. Starting and stopping the vehicle should be gradual and running on car tracks should be avoided wherever possible, as both are hard on tires.

Chains

ON vehicles using chains, those driving the wheels should be taken off once a month and washed with kerosene oil, after which they should be soaked in hot tallow or heavy grease. No other lubricant is needed. These chains should show some slack when running. Too loose, or too tight chains may jump off, stretch, wear out or run hard. Motor chains should be lubricated twice weekly with heavy grease.

Bearings

BEARINGS on the motors and on the wheels and countershafts are properly adjusted before leaving the factory. Under ordinary operating conditions they will need no attention for six months, except to clean in kerosene or gasoline and repack with non-fluid oil once a month or oftener if experience shows this to be necessary.

Wheel bearings should never be set so tight that they resist rotation. The wheels should be adjusted so that a little end shake can be felt, just enough to show that the bearings are not jammed. Loosening the axle nut one half turn after the wheel is set up tight is usually sufficient.

In some makes of vehicles the countershaft bearings may be adjusted for wear by adding thin steel adjusting washers between the bearing cones and the sprockets. These should be obtained from the maker. With the sprockets off both ends, one end should be adjusted until but little shake can be felt with the sprocket on this end. The other end should then be adjusted by adding washers until the shaft turns hard after the sprocket is drawn up tight. The sprocket should then be removed and one washer removed, after which it should be replaced.

In single motor types of vehicles the differential should receive the same inspection and lubrication as the bearings. The grease cup should be screwed down one turn every morning and all other parts oiled twice weekly.

Graphite should not be used, nor the bearings taken apart. Acid should not be permitted to get into the bearings.

Steering Gear

ALL parts of the steering gear bearings must be kept properly lubricated. The setter shaft bearing is oiled from the top by removing the oil cup cover. The pinion and setter should be well lubricated with heavy grease. The upright steering head pins on either end of the front axle should be removed about once a month and washed in kerosene oil. All nuts and joints should be kept in good adjustment to prevent lost motion.

JAMES MCCREA, president of the Pennsylvania Railroad, in a letter to a magazine calls attention to the danger of trespassing. He said: "It is horrible to me to think of the number of trespassers that are killed or injured on the lines of the railroads, simply because they pay no attention to the laws on the subject. On the Pennsylvania System alone, in the last 10 yr., there were 8523 trespassers killed, and 8285 injured. The danger to the public due to the custom of carrying concealed explosives on passenger trains and trolley cars is also very great. To what extent this practice is indulged in, of course, we cannot tell, but we know that it is done much more than is realized by the public. This is particularly true as to foreigners engaged in mining operations of various kinds."

WHITE FOLK'S WASH comes in mighty handy around Aunt Dinah's cabin, as illustrated in Laundryman's Guide by a cartoonist. There is good humor in the drawing, which shows how towels, bedding and wearing apparel are used to serve the purpose of the colored family, but no exaggeration. Indeed, the artist might show worse things than Dinah does with the clothes—if he dared. Families who let their washing be "toted" to unsanitary and filthy, germ infested negro cabins need not expect good treatment of their duds, and they need not be surprised if some contagious or loathsome disease breaks out in their homes after the much-abused laundry comes back. It is well known that a number of different diseases afflict many thousands of people in the United States every year as the direct result of unsanitary hand laundering, among them the frightful malady of tuberculosis.

ELECTRICAL CALCULATIONS

Applications of Arithmetic and the Slide Rule to Finding Various Properties of Copper Wire

By Richard Howarth

THERE are numerous properties of copper conductors that can be figured arithmetically and by means of the slide rule which is often found convenient if a wire table is not at hand.

Example: Find the area in circular mils, the weight and the resistance at 75 deg. F. of a copper conductor 1000 ft. long and 50.82 mils in diameter. Area in circular mils $= 50.82^2 = 2582+$. In this case the fraction can be omitted, as such a refinement is unnecessary when dealing with circular mils as explained in the June 1st issue of Practical Engineer.

$$\text{Resistance of conductor} = \frac{10.8 \times 1000}{2582} = 4.182 \text{ ohms.}$$

Where 10.8 is a constant equal to the resistance of one mil-ft. of wire, multiplied by the length of the conductor, the product being divided by the conductor's area in circular mils.

Weight of conductor = weight per mil-ft. × length of conductor × area in c.m = 0.000,003,027 × 1000 × 2582 = 7.81 lb.

To perform the operation on the slide rule, set 50.82 on C scale over right-hand index on D scale and under right-hand index on A scale find 2582 circular mils. It will be seen that this operation squares the diameter in mils and equals circular mils. To obtain the number of places mentally multiply 50 by 50, giving 2500 or 4 places, then the answer in circular mils has 4 places.

Over 10.8 on B scale find 4.182, the resistance in ohms. To find the decimal place refer to the arithmetical formula and use approximate cancellation, thus: 1000 is contained in 2582 approximately 2½ times and 2½ is contained in 10.8 a little over 4 times. From this result it is known that the answer to the problem containes one figure to the left of the decimal place.

To find the weight place the runner over 3027 on A and find 7.81 on B, the weight in pounds.

This example may be expressed in the form of a proportion as follows:

$$\frac{1}{(2582 \times 1000)} = \frac{0.000,003,027}{X}$$

Multiplying both sides of this equation by 1000 twice then by 2.58 will move the decimal place six points to the right, so that the answer will have one figure to the left of the point.

From these operations it is plain that the slide serves as a wire table. When it is necessary to obtain the properties of wire above 100 mils in diameter, use the left-hand index of C and D scales, placing the diameter in mils of the wire over the left index on D and under left-hand index on A, find area in circular mils. To obtain the other values, proceed as before.

Heat Loss

HEAT loss is equal to the square of current multiplied by resistance. What would be the loss in a circuit of 10 ohms resistance carrying 50 amperes? By arithmetic this would be 50×50×10=25000 watts. What is the resistance of a copper wire 1050 ft. long having an area of 8234 circular mils? By arithmetic we have $1050 \times 10.8 \div 8234 = 1.37$ ohms resistance.

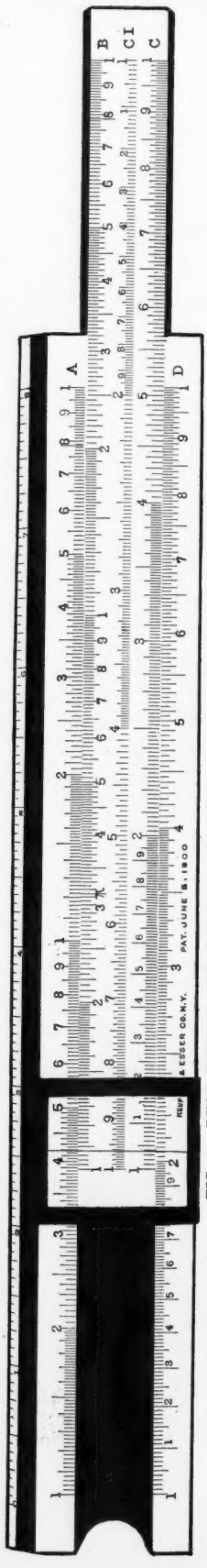


FIG. 1. RULE SETTING FOR FINDING THE AREA, WEIGHT AND RESISTANCE OF COPPER WIRE

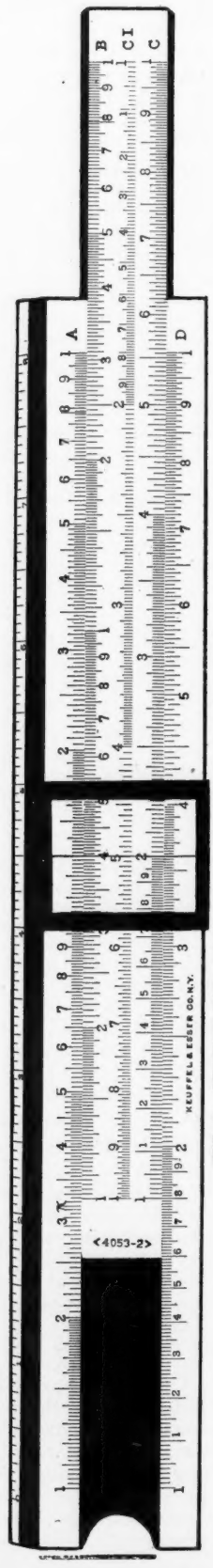


FIG. 2. SETTING FOR CHANGING FAHRENHEIT TO CENTIGRADE SCALES OR VICE VERSA

Now to do it on the rule place 1 on B under 1050 on A and place runner to 10.8 on B, place 8234 under the runner and over 1 on B find 1.37 on A, the answer.

If a current of 20 amperes is maintained through a resistance of 25 ohms, what is the electrical hp.? Energy developed in the circuit in hp. $= C^2 \times R \div 746$ and by arithmetic we have $20 \times 20 \times 25 \div 746 = 13.04$ hp. On the slide rule place 1 B under 20 on A and runner; runner to 20 B; 1 B to runner; runner to 25 B. Place 746 on B to runner, and over 1 on B find 13.4 hp.

In connection with electrical plants thermometers are often used and to change from Fahrenheit to Centigrade by the aid of the slide rule; use C and D scales. Set 5 on C over 9 on D and read degrees Centigrade on C scale and degrees F. on D scale plus 32.

EFFICIENCY TESTS OF MOTOR PULLEYS

Report of Tests Made at Lowell Textile School, Lowell, Mass., by George H. Perkins, S. B., Head of Engineering Department

PRIMARY PURPOSE OF the tests reported herewith was to determine the relative value of the various types of commercial motor pulleys by making comparison, under like conditions, of their influence upon the "overall" efficiency of a motor drive. There have been many extensive laboratory tests made on belt transmission and there is an abundance of data available bearing upon the complex relations that exist between such important factors as belt speed, tension, slip and coefficient of friction.

While much of this data is of scientific interest and value, it is nevertheless of minor importance to the average user of belts, who as a rule is not sufficiently conversant with the mathematical theories of belt transmission to make any practical application of them to his immediate problems.

Opinions of engineers are still widely different in defining the best conditions necessary for the most efficient belt drive and there is still a broad field for further experimental work. Perhaps the most marked tendencies in belt transmission during recent years have been along the following lines:

Increase of the tractive power of pulley and belt surfaces; decrease of the working belt tensions; increase of the belt speeds. The present series of tests were made with the belief that the average belt user is more vitally interested in the "overall" efficiency of his drives and in the improvement of any conditions contributing to it, rather than in such uncertain and little understood relations as exist between slip, coefficient of friction, etc.

Maximum output for minimum input means efficiency for the belt drive as elsewhere and is the objective of all power users. It was the aim to show such users in a simple and direct way the extent to which any particular type of pulley influences the efficiency characteristics of the entire transmission.

Description of Apparatus

APPARATUS used consisted of the following: Belt tension device consisting of supporting frame for motor; adjusting screw; rocker shaft; platform scales; absorption brake with 20 by 8 in. water cooled pulley; regulating device; electrical instruments; tachometers and electrical contact device for measuring belt speed.

Tension device was placed on the driving end, in order to eliminate errors which would be introduced by the brake arm and the motor was balanced on the supporting frame in a neutral position. The zero reading of the brake was determined in the usual manner; driven pulley was 30 by 60 in. wood rim corked to an amount of 33 per cent of the total pulley surface, and the belt was a 6-in. single, new and clean and no dressing or preparation of any kind was applied to the surfaces of either pulleys or belt.

It should be noted here that the surface of the plain paper pulley was treated with the usual preparation applied by the manufacturers of these pulleys. This dressing, when warmed either by the friction of excessive slip or otherwise, apparently has a higher coefficient of friction than when cold. There was no dressing of this kind on the corked paper pulley. The arcs of contact were as follows: Driving pulley, 170 deg.; driven pulley, 190 deg.; distance between shaft centers, 11 ft.

Method and Conditions of Testing

PRESENT tests covered a period of about 3 months and it was concluded to conduct them under one set of conditions only, and by eliminating all possible variables make a sufficient number of trials to obtain true comparative results.

Sum of the working belt tensions $(T_1 + T_2)$ was maintained constant at an amount equivalent to 75 lb. per square in. of cross section of the belt. While this would be considered a moderate belt tension, it was chosen after a number of preliminary trials, as approximately the minimum tension at which the rated load of the motor could be delivered to the driven shaft at a fair per cent efficiency. It was also recognized that the sum of the belt tensions is not a constant under working conditions and increases with the load beyond a certain minimum point; but it was considered of more importance to eliminate the belt tension as a variable factor from the data.

Voltage at the motor terminals was maintained constant by hand regulation and the motor speed showed the same characteristics in all tests. Care was also taken not to run tests when the motor had warmed sufficiently to affect its efficiency through heating losses. The motor was also carefully calibrated previous to the tests and the characteristics obtained served as a check on the overall efficiency obtained for the entire transmission. The belt slip was determined by observing the belt speed by an electrically actuated counter and comparing the results with the surface speed of both pulleys.

In each test the brake load was applied by ½ hp. increments beginning with 1/5 hp. and extending to the limit fixed only by excessive slippage at the motor pulley. The data for each test included the following items: Revolutions per min. of both driving and driven pulleys; belt speed per min.; electrical input at motor; mechanical output at brake shaft; sum of working belt tensions $(T_1 + T_2)$. Complete set of at least 2 separate tests on each of the six pulleys was made on each day that experiments were conducted, thus giving check results under the same conditions.

Data on Pulleys Tested

THERE were 6 motor pulleys used in these tests, the specifications of which are given in the following table:

No.	Pulley	Diameter	Face	Total Surface	No. of Corks	Diameter of Corks	% of Cork to total Surface
1	Cast iron, plain	9 in.	6 in.	169.5	0		0
2	Cast iron, corked	9 in.	6 in.	169.5	135	7-8 in.	47.8
3	Wood, Plain	9 in.	6 in.	169.5	0		0
4	Wood, corked	9 in.	6 in.	169.5	135	7-8 in.	47.8
5	Paper, plain	9 in.	6 in.	169.5	0		0
6	Paper, corked	9 in.	6 in.	169.5	133	7-8 in.	47.1

These pulleys were all carefully turned to a common diameter and the circumferences were checked by steel tape measurement. All of the corked pulleys had practically the same percentage of cork to the total surface, the small difference on the paper pulley being due to the omission of corks to allow for set screw holes. The corking was carefully done and the corks were sand-papered with the pulley running to a uniform projection of 1/32 in. This is an important point and should not be overlooked in using corked pulleys. The projection allowed should be such the working belt tension will compress the corks to a point where the pulley surface presented to the belt will be a composite one.

Results

SUMMARIZED results of these tests are tabulated in the following tables:

Pulley	Max. Eff.	H. P. at Max. Eff.	Max. H. P.	Eff. at Max. H. P.	Eff. at 2% slip	H.P at 2% slip	Rel. H.P at 2% slip
Paper, corked	78.5%	8.6	11.3	70%	78%	8.0	100
Wood, corked	79.0%	8.6	11.2	69%	79%	8.0	100
Cast Iron, corked	78.5%	8.6	11.4	69%	78%	7.9	99
Paper, plain	74.5%	8.5	10.6	68%	72%	6.8	85
Wood, plain	70.5%	7.2	9.4	63%	68%	5.5	69
Cast Iron, plain.	69.0%	6.8	9.0	59%	65%	5.2	65

Note:—In this table the efficiency referred to is the "overall" efficiency of the drive and, hp. is net brake horsepower delivered at driven shaft. "Overall" efficiency takes into consideration all electrical and mechanical losses.

Making a comparison of the power delivered at 2 per cent slip (assumed commercial allowance) from the above table we have the following:

Pulleys	% increase H. P. at 2% slip
Cast Iron, corked over paper plain	14%
Wood, corked over paper plain	15%
Paper, corked over paper plain	15%
Wood, corked over wood plain	46%
Cast Iron,corked over cast iron plain	52%

These results are shown more fully by the curves on diagrams 1, 2, 3 and 4 in practical reference table. Diagrams 1, 2 and 3 show the efficiency characterestics of the drive for the 3 types of pulley used both with and without cork inserts. The shaded areas on these plots indicate the extent to which a corked pulley influences the efficiency of the drive. It will be noted that in each case the gain begins well below the maximum efficiency for the plain pulley and extends to a point considerably above. This fact is of importance on drives having either a high or a low load factor, both of which are most common conditions. In short, the corked pulleys help to flatten the efficiency curve of the drive and make it more nearly parallel with the motor characteristic curve.

Diagram 4 gives the combined results of all the pulleys tested. The curves obtained for all 3 of the corked pulleys were combined into one in this diagram for the sake of clearness as they were so nearly coincident.

Range of power delivered throughout which the cork pulleys have an efficiency equal to or greater than the maximum efficiency for plain pulleys is indicated in the table below.

Pulleys	H. P. at Max. Eff. for Plain Pulley	% of H. P. at Maximum Efficiency for Plain Pulley	
		Above Max	Below Max.
Cast Iron, corked vs. Cast Iron, plain	6.8	26%	67%
Wood, corked vs. Wood, plain	7.2	25%	54%
Paper, corked vs. Paper, plain	8.5	25%	23%
Cast Iron, corked vs. Paper, plain	8.5	26%	23.5%

Conclusions

FROM a study of the results of these tests the following conclusions may be drawn: Motor pulleys of either cast iron, wood, or paper, if properly equipped with cork inserts will show essentially the same efficiency characteristics; plain or uncorked motor pulleys of the same character give materially lower efficiencies under the same conditions. The efficiency increases in the following named order: Cast iron, wood, paper; corked motor pulleys contribute not only toward a higher but a flatter efficiency characteristic for the entire drive; plain motor pulleys are exceedingly sensitive to changes in relative humidity and also to dust, oil, etc.; corked pulleys are practically unaffected by these factors; corked motor pulleys will transmit at a relatively high efficiency and low belt tension, loads that are greatly in excess of the maximum loads for plain pulleys.

ONE OF THE faults of the combination center drill is that it must be fed into the work slowly or its point will break. The trouble, especially with small members, is that the small part does not cut large enough to clear itself, thus making it bind and very often break, and after it is usually so tight that it is impossible to remove it except by annealing. This defect can be overcome by grinding one lip a little longer than the other. The drill will then cut itself clear as well as faster, and if its point should become broken, it can be removed easily by rapping it a little. This is due to the fact that the hole will be a trifle larger than the point of the tool.—Gas Power.

ACCORDING TO ROY C. DAVIDSON of Fort Blackmore, Va., copper may be welded in the following manner: The pieces to be welded are placed in a fire and heated to a black heat, after which they are coated with borax. The 2 pieces are then removed and hammered. They are again returned to the fire and the process repeated. This is repeated once more after which the joint is covered with ferrous sulphate. The pieces are now placed in the fire again and heated as hot as the copper will stand without melting, and the joint hammered together. It will be found, the inventor states, that a sound and homogeneous joint will then be had.—Brass World.

CORROSION TESTS OF WROUGHT IRON AND STEEL*

Tests Covering Various Lengths of Time Under Varying Conditions.

WHEN THE QUESTION of the relative corrosion of iron and steel became a pertinent one, numerous laboratory or accelerated tests were conducted with wrought iron and steel pipe under various conditions resembling, as near as possible, those of actual service. A summary of these early tests, including the navy test, is interesting in view of the results of later comparisons of pipe found in service: (Table I.)

Thus the results of these various tests on materials manufactured from 6 to 15 years ago show on the average that steel in general lost 97-2 per cent as much weight by corrosion as wrought or puddled iron, and 96.1 per cent as much weight by corrosion as charcoal iron.

Later Tests

FOLLOWING these so-called laboratory experiments several investigations were carried on to determine the relative corrosion of wrought iron and steel in actual service. Prof. T. N. Thomson, principal of the International Correspondence Schools, in March, 1906, installed alternate pipes of these two materials in a hot water line and at the end of a year discovered that steel pipe had approximately a 7½ per cent longer life than wrought iron under such conditions. (American Soc. of Heating and Ventilating Eng'rs. 1908). Again from Nov. 18, 1907, to Nov. 30, 1908, a committee, of which Mr. Thomson was chairman, appointed by the American Society of Heating and Ventilating Engineers, carried on a similar test with alternate lengths of steel and iron pipes from several makers; this experiment checked up well with the first one and resulted in a report which concludes as follows: "We believe (this test) demonstrates that modern steel pipe of good quality is at least as durable as modern strictly wrought iron pipe of good quality and is much superior to a poor quality of wrought iron in this class of work." (Amer. Soc. H. & V. Eng'rs: 1909).

Corrosion tests in running mine water were carried on by Prof. Thomson, the Pittsburgh Coal Co., the H. C. Frick Coke Co., (Iron Age, July 12, 1906), and others, these indicating that steel is at least equal to wrought iron in resisting corrosion. The same result is evident on a test now in its seventh year comprising alternate iron and steel pipes in an atmospheric ammonia condenser at the Isabella Furnaces, Etna, Pa., and on several other parallel tests on ammonia condenser pipe. A number of gas companies conducted tests in moistened ashes which resulted in the use of steel pipe for such work. A test carried on under atmospheric conditions with alternate panels of iron and steel pipe in the river wall at the National Works of the National Tube Co., McKeesport, Pa., shows no marked difference between the corrosion of the two materials after being subjected to the elements for nearly 6 years.

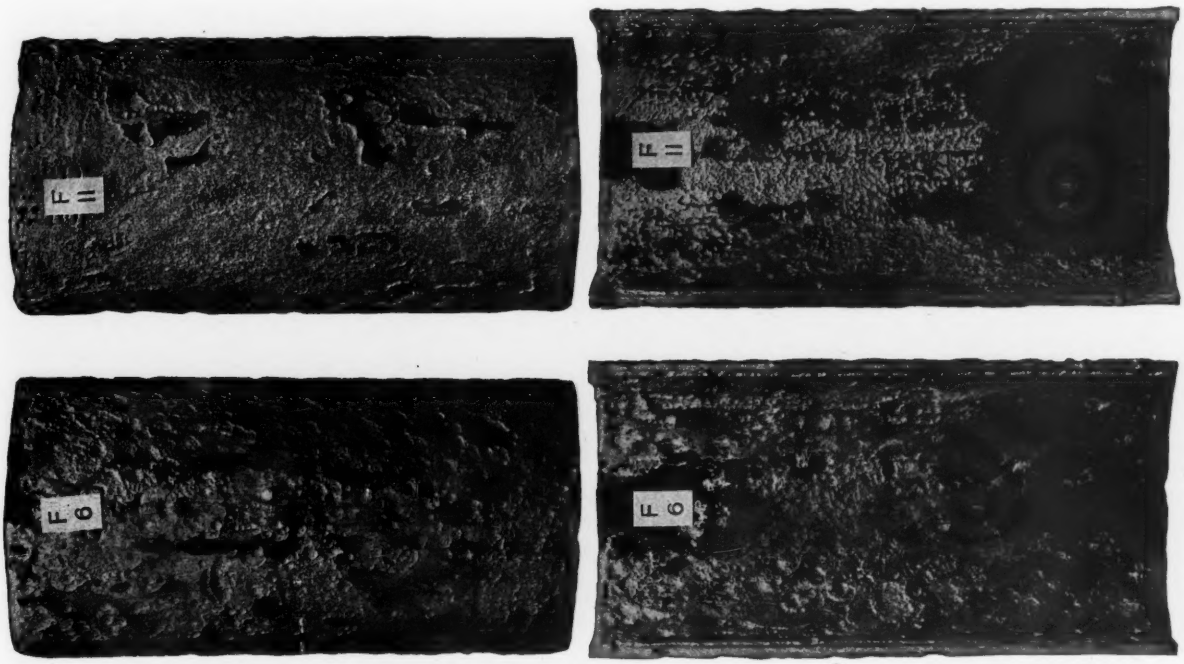


FIG. 1. CHARCOAL IRON LAP-WELDED TUBES, SHOWING CORROSION AFTER 16 WEEKS' EXPOSURE

Opinions of Authorities.

RESULTS of the foregoing tests, and many others not mentioned covering a wide scope, have led careful investigators to the conclusion that there is no inherent difference in the rust resisting powers of steel and wrought iron, that these 2 materials when subjected to the same conditions of service corrode at much the same rate. In his text book, "The Metallurgy of Iron and Steel," Bradley Stoughton, one of

*Abstract from National Tube Co.'s Bulletin.

those who have carried out exhaustive investigations, says: "The evidence goes to show that properly made steel corrodes no more than wrought iron." (p. 64). J. Newton Friend in his recent book entitled "The Corrosion of Iron and Steel," states: "It would appear, therefore, that when everything has been taken into consideration, there is practically nothing to choose between wrought iron and steel as at present manufactured" (p. 286), and finally concludes with these words: "These and many other instances might be cited as illustrating the fact that good steel corrodes at much the same rate as good wrought iron." (p. 288). A. Sang, in a thorough resume of the question entitled "The Corrosion of Iron and Steel," says: "Properly protected steel and iron rust to about the same extent, the steel doing so more uniformly," and adds: "The best quality of charcoal iron is practically as resistant as the best quality of steel used for similar purposes." (p. 49). In regard to pipe steel Sang remarks: "The carefully acquired experience of the largest manufacturers of tubes in the world which induced them recently to abandon the manufacture of wrought iron pipes, teaches that the use of steel in place of iron, at least in the United States, for the special purpose of tubing, is to be preferred; the tendency of the steel to pit is somewhat less than that of iron, and it welds at the joint fully as well." (p. 73).

Results in Service

WITHIN the last 2 years investigations have been made to ascertain whether the outcome of laboratory experiments and service tests of short duration, as well as the opinions of authorities are borne out in actual service. Comparisons of wrought iron and steel were sought in pipe lines where conditions were as nearly constant as possible from pipe to pipe. Hot and cold water lines, and exhaust steam lines meet these requirements possibly better than any others, especially hot water service lines where the pressures, temperatures and flow of water in adjacent pipes is practically constant, where the varying conditions of exterior corrosion and electrolysis are not encountered, and where the corrosion is generally of such violence that after from 3 to 10 years' service there is no difficulty in measuring its effect. In examining the specimens secured the deepest pit in each piece was usually considered as a measure of the corrosion, but the general condition of the pipe was also taken into account. In no case was the origin of the materials known absolutely, but the results may be taken as typical of the comparative rust-resisting qualities of wrought iron and steel as manufactured about 8 or 10 years ago.

TABLE I. SUMMARY OF RESULTS OF INVESTIGATIONS OF THE CORROSION OF WROUGHT IRON AND STEEL

No.	Date	Duration of Test	Conditions of Test	Authority	Material Tested	Relative Loss of Weight by Corrosion
1	1897	2 Years	Sea water normal temperature	Prof. H. M. Howe	Steel skelp W I skelp	117% 100
2	1897	2 Years	River water, normal temperature	Prof. H. M Howe	Steel skelp W I skelp	94% 100
3	1897	2 Years	Weather	Prof. H M. Howe	Steel skelp W. I. skelp	103% 100
4	1901	64 Weeks	Aerated distilled water, normal temperature	U S. Navy Department	Charcoal iron Pipe steel	100% 94 5
5	1904	6 Months	Aerated brine, normal temperature	Laboratory National Tube Co	Puddled iron Pipe steel	100% 206
6	1905	3 Months	Aerated water 180° F	Laboratory National Tube Co.	Puddled iron Pipe Steel	100% 90.6
7	1906	3 Months	Aerated brine 180° F.	Laboratory National Tube Co.	Charcoal iron Puddled iron Pipe steel	80% 100 75.3
8	1906	3 Months	Aerated sea water, 180° F.	Prof. H M Howe	Charcoal iron Puddled iron Pipe steel	94 4% 100 94.2

First investigation of this kind was made by Professor Ira H. Woolson, of Columbia University, who secured 89 samples of corroded pipe from 7 bathhouses in New York City. Seventeen of these specimens afterward proved to be wrought iron and the remainder steel, so that an excellent comparison of the 2 materials was secured. After a careful examination Professor Woolson declared: "In my judgment from the evidence collected, there was absolutely no

FIG. 2. HOT DRAWN SEAMLESS TUBES AFTER 16 WEEKS' EXPOSURE

FIG. 3. SAME SAMPLES AS SHOWN IN FIG. 2 AFTER 64 WEEKS' EXPOSURE

difference in the corrosion of the 2 classes of pipe (i. e., wrought iron and steel). They appear to be equally susceptible to attack." This pipe had been in actual service on an average of probably 5 years and it was tested to destruction.

In 1910-1911 a search was instituted in the hot water boiler feed lines of the H. C. Frick Coke Co. power plants to secure samples of steel and iron pipe adjacent to each other in the same line. Means were discovered to identify the material in the lines, which resulted in the finding of a number of cases where steel and iron pipes had been put in together. When these were removed and opened up for an examination of the pitting, it was found that the average of the deepest pit in each of the 26 iron samples was .112 in.

TABLE II. SUMMARY OF RESULTS OF INVESTIGATIONS OF THE CORROSION OF WROUGHT IRON AND STEEL IN ACTUAL SERVICE

No	Date	Locality	Length of Time Pipe Lines Were Installed	Character of Service	Authority	Number of Cases on Record	Average of Deepest Pits		References for Details and Remarks
							Wrought Iron	Steel	
1	1910	New York City bath-houses.	3 yrs. and over.	Hot water supply service.	Prof. Ira H. Woolson, Columbia University	89 samples secured, of which are wrought iron and the remainder steel	EQUAL 100%	100%	Eng. News, Dec 3, 1910, p 630. N T C Bulletin No 2. This was a test of iron and steel pipe in actual service continued to destruction
2	1910	Frick Coke Co. power plants	6 mos. to 7½-8 yrs., varying with the comparisons secured.	Boiler feed water lines	Research Laboratory National Tube Co.	21 lots comprising 82 samples, of which 26 are iron and 26 steel.	.112" 100%	108"* 96%*	Eng. Review, April, 1911. N. T C Bulletin No. 3, Amer Soc. Heating & Ventilating Engrs., 1911. Pipe samples secured from lines in actual use. In 22 cases of adjacent iron and steel pipes in same lines, 13 comparisons favor steel and 9 iron.
3	1911	Cresson (Pa.) coal fields	6 mos. to 10 yrs., varying with the comparisons secured	Hot and cold water boiler feed lines, pump discharge lines.	Research Laboratory National Tube Co.	9 comparisons of iron and steel found together.	.100" 100%	.085"* 85%*	Pipe samples secured from lines in actual use. In 9 cases of adjacent iron and steel pipes found in same lines, 4 comparisons favor steel and 2 iron, in 3 cases the steel and iron are equally corroded
4	1911	Allegheny General Hospital.	Between 7 and 8 years	Hot water supply service	Research Laboratory National Tube Co	69 samples from hot water lines, 42 wrought iron and 27 steel	.105" 100%	.105"* 100%*	Conditions those of actual service, and pipe was tested to destruction. In 13 cases of adjacent iron and steel pipes found in same lines, 7 cases favor steel and 6 iron.
5	1911	New England Investigation.	2 yrs. to 17 yrs., varying with the comparisons secured. Average 9 yrs.	Hot and cold water, live and exhaust steam, brine, boiler blow off lines, etc.	Dr. W H. Walker, Director Research Laboratory of Applied Chemistry, Massachusetts Institute of Technology.	54 comparisons of iron and steel found together, in hot water and steam lines.	.060" 100%	.063"* 91%*	Eng. News, Dec 21, 1911. Jour of New England Water Wks Assn Jan., 1912. Actual service conditions. In 54 cases of adjacent iron and steel pipes found in same line, 29 favor steel and 18 iron, 9 show no difference in corrosion and 7 no corrosion at all.

NOTE—Depth of pitting in wrought iron samples considered as 100% in all cases.
(*) Calculated from the deepest pit in each sample

and in the 26 steel samples .108 in., that in 22 cases where the two materials were found together 13 of these "pairs" favor steel and 9 iron, as far as resistance to corrosion is concerned.

A similar investigation in the power plants of several central Pennsylvania Coal Companies resulted in the discovery of 9 "pairs" of steel and wrought iron pipe which had been placed side by side when the line was laid. Four of these comparisons favor steel and 2 iron, while in 3 cases the corrosion was equal; the average depth of pitting in the steel pipes was but 85 per cent of that of the iron.

PRODUCTION OF COAL in Montana in 1911, according to Edward W. Parker, in a statement just issued by the United States Geological Survey, was 2,975,358 short tons, with a value of $5,339,058. The figures show an increase over the production for the previous year, which was 2,920,970 short tons, valued at $5,329,322.

IN TOO MANY cases the engineer and manager are intellectual and moral strangers to each other, even after years of close association. The manager can do more to promote intellectual acquaintance than the engineer and it will in most cases pay to make the effort. Some have said that "friendship and business cannot mix"; maybe not, but pleasant relations most certainly lead to mutual good will and confidence, the basis of a successful business of any kind.—Ice.

THE COMBINATION JOB

A Lesson in Cheap Lubrication

BY JOE BUSH

GENERALLY speaking, to be an engineer on the payroll is very satisfactory and to be one while on duty is all right, too, but with a generous company that insists on giving a working interest in a bunch of other jobs as a side line may or may not be all right.

These extras vary universally as to the size of the plant, the smaller the plant the greater number of extras for the engineer, and if he doesn't do his own firing he is handed a job lot of something else, and it's not at all unusual for this combination to make the engine itself merely an incident in the day's work.

There was a combination job of this kind at one of the large copper mines and to help break the monotony the engineer had to oil the crusher which was run by a 125-hp. engine with compressed air. According to the blue-print that job with its extra attached was a lazy man's idea of a snap, but the way it was handled made it almost a contract and the most undesirable engine job on the mine; it was a little job on a big scale.

The crusher was double belted, 23 by 36 in., with 11-in. shaft. The bearings had large openings for a liberal supply of grease and 5-gal. cans were used for oil cups with a generous drip of engine and cylinder oil mixed.

The one was so hard that it would sometimes spring the shaft; there was an extra one with babbited bushing to replace it and also to simplify the work of rebabbiting, which had to be done about every 3 months.

The crusher had to run to capacity regardless of hot bearings and the size of the oil bills, which were from necessity a secondary consideration.

The eccentric bearing could absolutely be depended on to run right up to within a few degrees of the melting point of babbit all the time and to keep the bearing from burning up it usually took about 2 gal. of grease and 1 of oil every hour. The higher priced lubricants were no better than the cheaper, so the buyer did his part by getting tallow from a slaughter house, and it wasn't the odorless kind either. The result was a mighty dirty job for the engineer.

Somehow, everyone concerned had the fool idea that water shouldn't be used on the bearings and it had never been tried until one of the engineers laid off for a couple of weeks and a man from the shop took his place. It took a few days to size up the layout and, not knowing of the ban on water, his first experiment was with it, by using it in the cans instead of oil. With plenty of water the bearings ran cool, and then to make the new system automatic and cut out the trouble of carrying water, connections were made to a water line and with the necessary fittings and ¼-in. valve over each bearing to regulate the feed everything was lovely, no more hot bearings, no babbit job at 3-month intervals, and no more oil bill; although a little grease was kept in the openings it wasn't necessary and it never melted, just wore away.

About 1 bbl. of water was used every 8 hr. and was drained to a pit whence it was pumped by a small pump run by air. That particular oil problem was solved by a new man in a few days and the big oil bill reduced to nothing; and at the end of the engineer's 2 weeks' lay off the solver went back to the shop at 50c less a day than the engineer job.

UTILIZING THE WASTE HEAT OF DIESEL ENGINES

Relation of the Actual Engine Efficiency to the Theoretical; Means Employed for Saving Heat of Exhaust Gases

By Francis G. Wickware

ECONOMY in the modern steam power plant owes a great deal of those improvements in design and construction which, over a period of several decades, have gradually added small increments to the mechanical efficiency of steam prime movers. When the practical limit in this direction was all but reached, efficiency in heat utilization became the prime consideration in steam engineering, and it is to the remarkably rapid development of apparatus for conserving and economizing heat that the reciprocating steam engine owes the greater part of its ability to compete with newer prime movers which possess an inherently superior thermal efficiency. Were it not for efficient heat insulating materials, the condenser, the economizer, the preheater, the mechanical stoker, the superheater, and, lastly, the exhaust steam turbine, the day of steam machinery as a factor in large scale power generation would long ago have passed.

At a much earlier stage of development, the internal combustion engine has been widely studied with a view to the utilization of the heat wasted in the exhaust and in the jacket water. In a few gas engine plants, heat recovery has already been practiced with a considerable degree of success, although prejudice and the disappointing results of some early experiments based on entirely wrong principles have militated against a wide adoption of heat economizing apparatus. More recently, the firm of Sulzer Brothers have conducted an investigation of the possibility of recovering the waste heat of the Diesel engine, the encouraging results of which have been reported by M. Hottinger in the Zeitschrift des Vereins deutscher Ingenieure.

Prof. E. Josse, in the latest edition of his book on prime movers, credits the Diesel engine with a conversion of heat energy into mechanical energy of 32 to 34 per cent. The theoretical thermal efficiency of the ideal Diesel cycle is about 56 per cent; hence, the Diesel engine is capable of a relative efficiency (empirical to ideal) of 61 per cent. These figures have been equaled in practical tests. Practical investigation has shown also that the heat recoverable from jacket water of motors of all powers and at all loads is at least 2000 B.t.u. per horsepower hour, and that under certain conditions the recovery may exceed 2800 B.t.u. per horsepower hour.

Sulzer Brothers' first experiments on the recovery of the waste heat of the exhaust were made with an apparatus which consisted of a cylindrical casing enclosing a nest of vertical wrought-iron tubes. The exhaust gases were impelled through these tubes, and the heat was recovered by water circulating in the casing. The experiments comprised tests with both parallel and series arrangements—that is, with jackets and economizer supplied with water at the same temperature, and with the economizer supplied with water already heated by passage through the jackets.

While the apparatus showed some faults of design, notably the provision of too small a heating surface, difficulty of access for the purpose of cleaning the tubes, and extremely rapid destruction of the wrought-iron tubes, the results clearly demonstrated the practicability of recovering in this manner a large amount of the heat carried by the exhaust gases.

The tests were continued last year on a new apparatus in which these defects of design were removed. A more suitable material was employed for the tubes, and a unit system of construction was adopted, capable of extension to any desired size and offering every facility for cleaning. The motor on which the experiments were made was of 150 hp.; the load was an electric generator working against a water resistance. It was demonstrated that at about normal load the heat recovery is at least 1600 B.t.u. per horsepower hour, while at loads lower than normal the recovery per unit of power delivered is considerably greater. The possibility of recovery of heat from jacket water and exhaust gases combined is, therefore, in no case less than 3600 B.t.u. per horsepower hour.

For parallel operation of engine and economizer, the latter should be designed for a heating surface of 2.15 sq. ft. per engine horsepower. This allowance is sufficient to permit a transmission of 736 to 1104 B.t.u. per sq. ft. of heating surface per hour, with an adequate margin for inevitable fouling of the surface, assuming that water is the medium utilized for the recovery of the heat and that the streams of gas and water flow in opposite directions. High velocities of both water and gas are desirable, a high gas speed being particularly important.

When the apparatus is to be installed for series operation, on account of the smaller temperature difference between gas and jacket water, a heating surface rather greater than 2.15 sq. ft. per engine horsepower must be provided in order to reduce the gas temperature from 392 to 932 deg. F. to about 212 deg. F., in spite of the unavoidable fouling of the heating surface.

The apparatus can be employed for the generation of low-pressure steam. As, however, the 2310 B.t.u. required to convert 2.20 lb. of jacket water at a temperature of 131 deg. F. into steam at a pressure of 15.65 lb. absolute must all be obtained from the heat in the exhaust gases, the production of steam is small. Still, it is sufficient for some minor heating purposes, for the production of distilled water in chemical works, and for similar services. Without generation of steam, water can be raised to a temperature of 212 deg. F. and over, and the apparatus can be used also for heating air for drying purposes.

In cases where the demand is for the greatest possible quantity of water at a temperature of around 122 deg. F., the jacket water will be used directly and the waste gases will be employed to heat cold water to this temperature. On the other hand, when the highest possible water temperature is desired, the series arrangement will be adopted. By proper design, the plant can be adapted to any combination of requirements, without in any way affecting the reliability or efficiency of the engine and with the advantage of eliminating the nuisance of a smoky exhaust.

HORIZONTAL COMPOUND AIR COMPRESSORS IN ENGLISH COLLIERY

New English Compressor Employing Disk Type Air Valves and Circular Double-beat Pattern Steam Valves

By C. Van Langendonck

ACCOMPANYING illustrations refer to a set of horizontal coupled compound steam engines and 2-stage air compressors capable of dealing with 6300 cu. ft. of free air per minute, when running at 56 revolutions, which has recently been installed at a Normanton (England) colliery.

The chief particulars of the engine, supplied by Robey & Co., Ltd., Lincoln, are as follows:

Boiler pressure	120 lb.
High-pressure steam cylinder, diameter	27 in.
Low-pressure steam cylinder, diameter	46 in.
Low-pressure air cylinder, diameter	46 in.
High-pressure air cylinder, diameter	30 in.
Stroke, common to all	60 in.
Piston rods, diameter	5 in.
Crank shaft, diameter at center	18 in.
Crank shaft, diameter at bearing	15 in.
Length of crank bearing	28 in.
Steel crank pins, diameter	9 in.
Steel crank pins, length	10½ in.
Flywheel, diameter	16 ft.

Figure 1 gives a view of the interior of the engine-house, while Figs. 2 and 3 give views of the air valves.

The steam cylinders are jacketed and supported on substantial feet. They are fitted with liners of a special mixture of hard cast iron, and are provided with automatic relief valves adjustable to the working pressure. The high-pressure cylinder is provided with

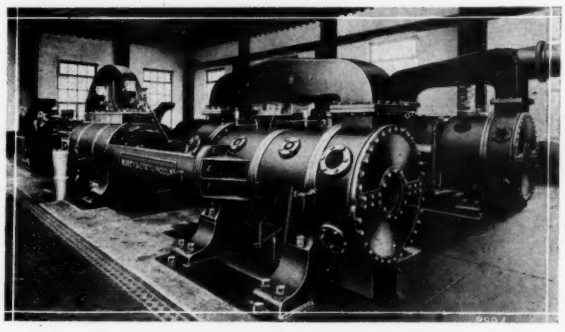


FIG. 1. HORIZONTAL COMPOUND AIR COMPRESSING PLANT AT NORMANTON COLLIERY

a clear way screw-down stop valve, and provision is made for admitting high-pressure steam to the low-pressure cylinder for starting the engine when necessary. The high-pressure cylinder is fitted with a Robey governor and automatic trip valve gear. The valves and seats are of the circular double-beat pattern, the valves being lifted and released by trip levers actuated by eccentrics driven from a horizontal shaft rotating at the same speed as the disk shaft, and lying parallel with the engine bed. The length of time of contact of the levers is controlled automatically by the governor, and the grade of expansion or cutoff is varied to suit the load. The exhaust valves of both steam cylinders are placed underneath for drainage purposes, and thus allow the pistons to work with the minimum clearance.

Like the high-pressure cylinder, the low-pressure cylinder has double-beat valves operated in a similar manner. The speed of the engine is controlled by a governor, and the governor is automatically actuated by the pressure of air in the receiver. The pressure is thus maintained uniform under all conditions by the speeding up or slowing down of the engine. The piston-rods are of forged steel, and are carried through the back covers to the air cylinders. They have metallic packings.

The air cylinders are double-acting, and placed in line behind the steam cylinders, being operated by a prolongation of the piston-rods through the back covers. These cylinders are water jacketed, the water

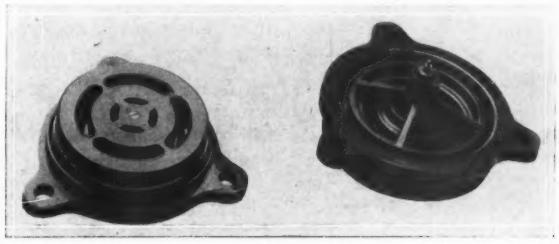


FIG. 2. INLET AND OUTLET AIR VALVES

necessary for both the jackets and the inter-cooler being circulated by means of a pump. The inlet and discharge valves are the chief features of the compressor, and are shown in Figs. 2 and 3. They are of the disk type, in which the use of guide studs or other supports liable to wear are obviated. The valves are suspended freely, and seat themselves automatically and without noise at each stroke. The inlet and outlet valves and seatings are identical in shape and interchangeable, the time required for examination and replacing of the valves is reduced to a minimum by a special arrangment of the joints and detachable seatings.

Valves are held in position by means of coiled springs of square section steel, which fit into the flanges of the outside and inside edges of the valve

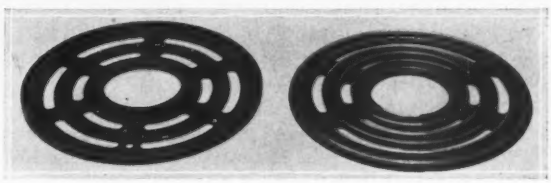


FIG. 3. AIR VALVE DISKS

at one end, and at the other are held by the guide plate. With this arrangement the valve is held firmly in position against the valve seat, and is free to move in all directions towards the guide plate. The disks are made from a special quality of steel plate and are corrugated, so that the maximum of strength is combined with elasticity; having multiple ports only a slight lift is required, and this reduces noise to a minimum.

Crank shaft is of the best mild steel, and swelled in the middle to receive the flywheel, which is keyed on. The bed-plate is of heavy section, with a massive base forming the main bearings. The guides for the piston-rod crosshead are bolted to the cylinder flanges. The main bearings are of cast iron in 4 parts, lined with antifriction metal, and the beds are bored horizontally and vertically to receive Robey's special circular wedge, which makes unequal adjustment impossible. The cranks are of forged steel, and fitted with steel crank pins. The connecting rods are of the best steel, the large end being fitted with a suitable bearing lined with antifriction metal and having cotter adjustment. The small end has a gun metal bush and suitable adjustment. The crossheads and gudgeons are of high quality steel, secured to the piston-rods by steel cotters and provided with adjustable cost-iron slippers.

LOOKING AFTER THE AIR COMPRESSOR

Setting the Meyer Riding Cutoff Valve Gear and the Effect of "Running Under"

IN many air compressors the Meyer cutoff is used, and the question has arisen why the eccentris for the cutoff valve should be "set in line with the crank," also what effect, if any, the fact that many compressors run under instead of over has had on the valve settings. In order to clear up these points, it seems desirable to give the directions for setting the Meyer slide valve as used on compressors and also a brief statement in regard to the running under feature.

It should be remembered that the Meyer or riding cutoff valve is in reality 2 valves, one of which controls admission, exhaust and compression, and the other controls the cutoff, this second valve riding on top of the main valve and being so arranged that it leaves the port through the main valve open at admission.

Setting of the main valve is therefore the same as that for an ordinary D slide valve, remembering that admission is performed by the edge of the port through the valve and not by the end of the valve. In the case of the Ingersoll-Sergeant compressor, which may be taken as typical, the crank should be put on dead center, and the main valve for that end set so that it has about 1/64 in. lead, the eccentric being set at about 15 deg. ahead of the 90-deg. point, that is about 85 deg. ahead of the crank. The main valve is usually movable on the stem, and the nuts should be set up temporarily against the valve after it has been put into position as outlined. The compressor should now be turned with the crank at the other dead center and the lead measured. This should be approximately the same as that for the other end of the stroke and if it is not should be equalized by moving the valve on the stem. When the lead has been exactly equalized, the nuts should be jammed up tight against the valve, and the length of the valve stem is correct.

The crank is now put on dead center and the eccentric moved to give 1/64 in. lead and the eccentric is then made fast on the shaft.

Cutoff valves are usually made in 2 parts, screwed on the same valve stem, and often arranged so that turning the stem moves them together or apart according to the desire of the operator.

In arranging the cutoff, it is possible to get this equalized only at one point in the stroke, and for any other point the cutoff will not be equalized. The point at which cutoff is to be equalized should be determined and that point laid off for both forward and return strokes along the crosshead slide. The crosshead is then set at the desired point, and the cutoff valve is moved by turning the handwheel on the stem so that it just cuts off the port on the main valve. The crosshead is then moved to its corresponding position on the other stroke and the cutoff valve should just close the port on the main valve at that end. If it does not, the valve stem should be lengthened or shortened in the eye end, or one of the parts to the cutoff valve should be put on the stem a thread or two sooner than the other so as to equalize the cutoff.

As ordinarily designed, the cutoff eccentric is arranged to stand at 180 deg. or about that with the crank, provided the valve is direct driven. If the valve is driven through a reversing rocker arm, the cutoff eccentric would stand approximately with the crank.

Sometimes, in order to give a little more rapid motion at the time of cutoff, the cutoff eccentric is placed a little less than 180 deg. ahead of the crank. This is the setting usually found on air compressors, but it should be understood that by changing the position of the valve on the stem and the angle of the eccentric, any eccentric position may be given between 196 deg. ahead of the crank and 60 deg. behind it. If the setting be less than 169 deg. ahead of the crank, the main valve will cut off, and the cutoff valve be useless, while if it be less than 90 deg. behind the crank the cutoff valve will re-open before the main valve closes, thus producing a re-admission of steam.

As to running over or under, this is in some types a matter of evolution, and in other types a case of necessity. Where a compressor uses the splash system of oiling, it is essential that it should run under in order to lubricate properly. The reason for running under in other types is that the bearing of the crosshead comes upon the bottom guide which offers the greatest strength or resistance to the crosshead. With a bored guide, there would not be necessity for running under, but many makers of compressors prefer to have all of them uniform, and therefore run all types under.

TO CLEAR A CYLINDER OF FRAGMENTS

IT occasionally happens that a broken valve or spark plug proves a source of considerable annoyance and expense because of the difficulty of removing the broken fragments from the cylinder. This difficulty is most likely to arise in motors which have cylinders mounting the valves in offset pockets, so that there is no really sizable opening directly into the bore proper. Sometimes, probing with a wire or a pair of long nosed pliers will suffice, but more often the parts must be left in the cylinder to work whatever harm they may, while the car is run to the nearest garage on the other cylinders, pending opportunity to take down the cylinder and clean it out.

A simple method is that of jacking up one side of the machine as high as is possible, taking advantage of the pitch of the road at the gutter, whenever possible, and after removing the valves, cranking the motor as rapidly as possible. The loose particles of broken metal or porcelain will then be thrown upward by the piston, and ultimately will hop out into the valve pocket, from which they can be removed without further difficulty.—Gas Power.

WATER SYSTEM HEATING AND VENTILATING

Description of the Salient Features, Suggestions for Operation and Care

By J. P. Fleming

SYSTEM OF HEATING and ventilating used in the Chicago Public Schools, as designed by the late Thomas J. Waters, Chief Engineer of the Board of Education, is, briefly, a scheme whereby the heating and ventilating are combined in one, thus eliminating all steam pipes above the basement.

Constant volume of air is heated to the desired temperature, by contact with steam pipes, by means of a blower, and then forced through ducts under a pressure of approximately ¾ ounce to the rooms that are to be heated; where the temperature is maintained at a predetermined point of thermostatic control.

Figure 2 is a plan view of the heating system of a 19 class-room school building, equipped with manual training, domestic science, dining rooms and assembly hall. There are accommodations for 900 pupils. The air is supplied at a rate of 30 cu. ft. per pupil per minute.

Heating surface consists of 5120 sq. ft. of 1-in. pipe, located in the basement and divided into 3 groups, as shown in Fig. 2. In more recent installations the tempering coils are between the fan and the heating coils.

Each room has an individual duct; the mixing damper is under control of a thermostat located in the classrooms.

These heaters are divided into 2 or more separate groups, one of which is between the blower and the outside air. This consists of 1 section, 4 pipes deep, and is used to temper the air.

The blower is usually of the double-throw type and is centrally located, with a group of heaters on each side, 4 sections to a group. Each section has a separate admission and return valve, so that one or more sections may be operated as required. These are the heating or blast coils that raise the temperature of the tempered air to the point required, depending, of course, on the outside temperature.

In Fig. 3, AA are bypasses under the tempering coils, closed by doors under thermostatic control; this thermostat is located in the tempering chamber at C. BB are open bypasses under the heating coils and have areas equal to the air passage around the heating coils, either one of the passages (through coils or bypass) will admit all the air required, if the other is closed by operation of the mixing damper.

Mixing dampers are located as shown in Fig. 2, and in Fig. 3 at D. This is the only place in the Waters system where double ducts are used. The lower damper controls the admission of temperate air and the upper damper the hot air, either opening is larger enough to supply all the air needed for the

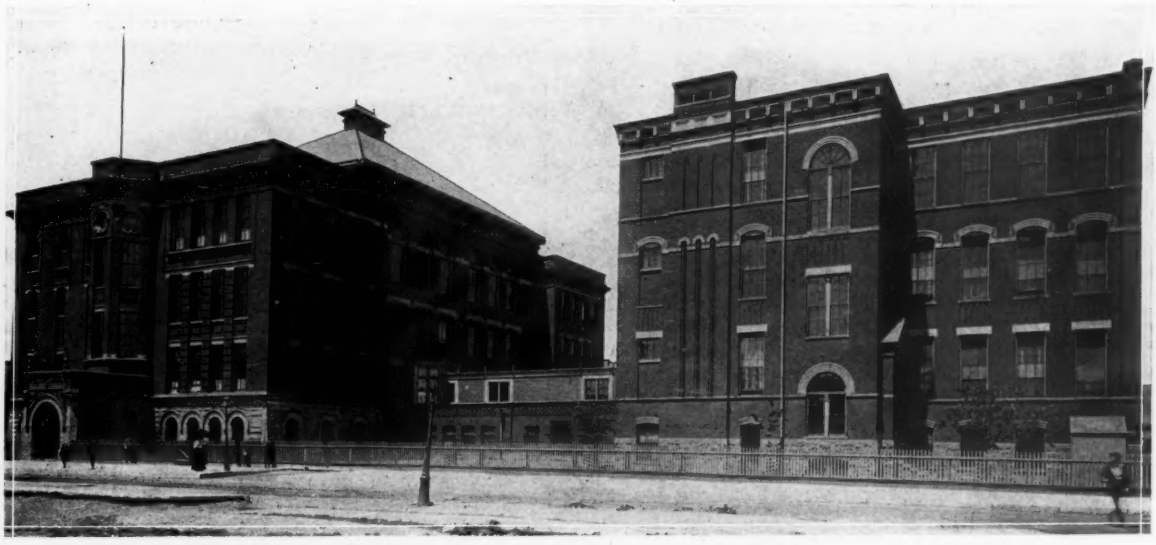


FIG. 1. VON HUMBOLDT SCHOOL, CHICAGO

Description of the System

HEAT required to maintain a temperature of 70 deg. F. when the outside temperature is zero, is first determined. The number of boilers necessary to evaporate water to heat the required volume of air, is installed. Steam engines of the plain slide valve design, have, until quite recently, been used exclusively to operate the blower. In a few instances electric motors are now used.

Heaters, consisting of 1-in. vertical staggered pipes, joined at the bottom by a common base and in pairs at the top by U-bends, are used to raise the temperature of the air before entering the ducts leading to different parts of the building.

room to which the duct D^1 leads. Thus a constant volume of air is furnished regardless of temperature.

Mixing damper D is actuated by a diaphragm motor at E, Fig. 3. The operation of the mixing damper D is controlled by a thermostat in the class room placed about 4 feet from the floor line at point F in such position as to be affected by the changes of temperature in the room. A full description of the thermostat and how it operates appeared in the May 1 issue of Practical Engineer.

When the temperature of room is at or below the minimum allowed, the lower damper is closed and the upper or hot air damper is wide open, thus admitting only hot air to the room through the duct D^1. When

the temperature of the room reaches a maximum the thermostat operates and admits compressed air at 15 lb. pressure, under the diaphragm of the motor E, this in turn causes lever G to move, which is attached to the mixing damper D, and causes it to partly open the tempered air damper and at the same time to partly close the hot air damper; this causes the temperature of the air in the duct D^1 to fall and consequently to help maintain the normal temperature in the room. However, if the temperature of the room continues to rise, more compressed air is admitted under the diaphragm by further action of the thermostat and the dampers are flixed still more, admitting more tempered air and less hot air, until the temperature of the room becomes normal.

If the temperature of the room should drop below normal, the thermostat releases some of the compressed air and by reaction of coiled springs on the

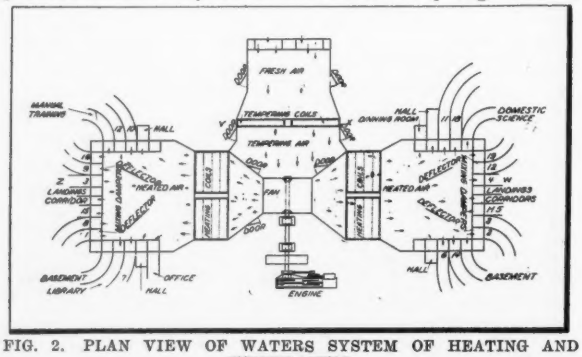


FIG. 2. PLAN VIEW OF WATERS SYSTEM OF HEATING AND VENTILATING

diaphragm motor E the lever G is compelled to move back, thereby decreasing the amount of temperate and increasing the volume of hot air, by action of the mixing damper D.

Air, after passing through the mixing damper D, is guided to the inlet I, Fig. 3, by means of duct D^1. At the point H, volume dampers are located in all ducts for the purpose of regulating the amount of air supplied to each room. The inlet I is located 6 or 7 ft. from the floor line and the cross sectional area is much larger than that of the duct leading to it, thus the velocity of air entering the room in much reduced, so that no draft or movement of air is noticeable to the occupants, the air flows along the ceiling to the rear, if possible from an inside to an outside wall, following approximately the direction of the dotted lines as indicated by the flying arrows in Fig. 3 and discharging into the exhaust outlet duct at point J, Fig. 3, thence up the vertical stack K to the roof and outside of building.

About 75 per cent of the air forced into the room escapes through the vent stack, the balance through open doors, etc., thus a slight pressure is maintained in the room.

Ventilation of toilet rooms is independent from the balance of building. Usually the vent ducts from the toilets are connected with the smoke stack so as to utilize the aspirating effect of the chimney when operating. In some cases electrically driven fans are used.

Operation

WHEN the engineer arrives at the school building, assume outside temperature to be 8 deg. F. Steam is raised in the boilers, the main valve to the heating system is opened through which steam leaks and piping is thus warmed slowly; undue strains caused by hot steam in large quantities coming suddenly in contact with cold pipes is avoided. All valves to tempering and heating coils are wide open as they were left when shutting down the day before in order to thoroughly drain them.

After the preliminary heating of coils and return pipes are hot, the main heating valve is slowly opened wide, sufficient weights are then added, one at a time with interval of 2 to 5 minutes, to the reducing pressure valve to produce about 5 lb. pressure on the heating coils.

Outside windows to air chamber are opened to admit fresh air; the engine is then started and slowly brought up to speed.

The condensation from tempering and heating coils is removed by means of a wet vacuum pump, and the return is sent to a receiving tank, located in the pump room, where it is fed to the boilers by means of a steam pump.

During school hours the maximum temperature allowed in class rooms is 68 deg. F., the minimum 65 deg. F.

Normal temperature of class rooms being attained, the pressure on the heating system is gradually reduced and as the outside temperature rises, heating sections are cut out one at a time, commencing with the section nearest the fan. Sufficient heat should be supplied so that the mixing damper of the coldest room is just beginning to flix; less heat will not maintain the required temperature more than this.

Under normal conditions the temperature of air in the tempering chamber should be 65 deg. F. If by an increase in the outside temperature or for any other reason the temperature of air in the tempering cham-

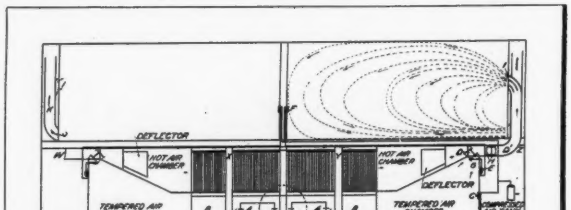


FIG. 3. ELEVATION THROUGH X-Y AND W-Z SHOWN IN FIG. 2

ber rises to above 65 deg., then the doors AA, Fig 3 will open by means of the diaphragm motors LL, as previously described in connection with motor E. The air at outside temperature then enters through the bypases AA and lowers the temperature of the air in the tempering chamber. When the temperature is reduced to 65 deg., doors AA will close and air must then pass through tempering coils.

It is the duty of the engineer in charge to see that just enough steam is admitted to the tempering coils to maintain a temperature of 65 deg. in tempered air chamber, without operating the bypass doors AA, and for this reason the operator must closely watch the outside temperature. He should also visit the tempering chamber frequently to ascertain position of mixing dampers in order to maintain a normal temperature in class rooms, with a minimum amount of steam. This is accomplished by reducing the number of heating sections in time to avoid rooms from taking tempered air exclusively. The most efficient results are obtained when the normal temperature of class rooms are secured with a minimum amount of air passing through the mixing dampers.

These readings were taken from actual practice, Jan. 3, 1912:

Class room temperature.	Outside temperature.
First Reading 25 deg. F.	8 deg. F.
End of 1st hour 47 deg. F.	11 deg. F.
End of 2nd hour 59 deg. F.	12 deg. F.
End of 3rd hour 65 deg. F.	12 deg. F.

This classroom is in the northwest corner of the building and is used by the writer as an indicator for balance of rooms when the wind is in the northwest, as it was when these readings were taken. At the end of the second hour all of the other rooms were over 65 deg. F.

Following readings were taken the same day as the previous readings.

Hot Chamber Temperature	Tempering Chamber	Pressure on Coils	Boiler Pressure
End of 1st hr. 130 deg. F.	59 deg. F.	4 lb.	55 lb.
End of 2nd hr. 133 deg. F.	60 deg. F.	5 lb.	60 lb.
End of 3rd hr. 140 deg. F.	65 deg. F.	5 lb.	60 lb.

On Jan. 4, 1912, these readings were taken by the teacher in room 2, located in the northeast corner of top floor. Direction of wind northwest:

Classroom Temperature	Outside Temperature
9 a. m. 66 deg. F.	6 deg. F.
10 a. m. 67 deg. F.	6 deg. F.
11 a. m. 68 deg. F.	5 deg. F.
12 m. 68 deg. F.	5 deg. F.
1 p. m. 68 deg. F.	6 deg. F.
2 p. m. 68 deg. F.	5 deg. F.
3 p. m. 68 deg. F.	5 deg. F.

Negative answers were given to the following questions:

Is your room too hot or too cold at any time?

Do you feel a draft at any time?

Do you feel the air heavy at any time?

It is not customary to take hourly readings of class rooms. However, the writer occasionally requests teachers to take readings and report conditions of class rooms, regarding air, temperature, etc.

Care of System

AS in all steam power plants, the boilers require the most careful attention in order to maintain a safe and economical steam generating outfit.

Gages for steam, air and vacuum should be watched to see that proper pressures and vacuum are carried.

The engine should run with the minimum amount of noise, to that end knocks and pounds must be eliminated by careful attention to necessary adjustments. The amount of steam consumed by the engine is immaterial, as all of the exhaust is utilized in the heating system; the motive power to drive the fan is thus obtained at practically no cost.

Operation of the thermostat must be thoroughly understood, as adjustments are sometimes necessary.

Volume dampers H, Figs. 2 and 3, should be marked in position and examined frequently, in order to correct any displacement by unauthorized persons through design or accident.

On shutting down at close of school day it is important that all condensation be drained from heating system; to this end bypasses to traps, bleeders and drains to system should be opened at time of shut down and left so until again in operation.

All steam leaks should be immediately attended to, so as to avoid waste of fuel and eliminate any possibility of danger.

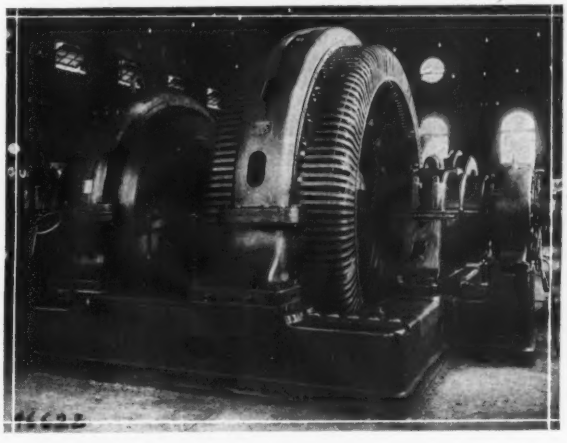
In order to prevent accumulation of oil in boilers, the minimum amount of oil required to keep cylinders of engines and pumps in good order should be used; for the same reason oil extractor on exhaust should be kept in good working condition.

School power plant is similar to all steam power plants in that the progressive engineer will endeavor to obtain the highest degree of efficiency by constant attention to duty and exercising eternal vigilance.

SYNCHRONOUS MOTOR TO RAISE POWER FACTOR

AN interesting application of a Westinghouse synchronous motor-generator set is that in the Tunnel sub-station of the Pittsburgh Railways Company. This is an application of a synchronous motor used for power factor correction and driving a mechanical load.

The machine consists of a 1500 kw. synchronous motor-generator set running at 360 r.p.m. The generator is wound for 550 volts, direct-current, and supplies energy to the trolley system. The motor, wound for 10,000 volts, 60 cycles, has a rating of 2340 kva. and was especially designed for operation at 70 per cent power factor for corrective purposes. The size of the motor with respect to the generator is shown in the illustration. At present, the load on the system supplying the motor-generator is of such a nature as to make advisable the operation of the set at only 100 per cent or at very slightly leading power factors. In the event, however, of a change in the character of the load, there is available for power factor correction purposes, in addition to the corrective effect of the power component furnished to the direct-current generator, 1635 leading wattless kva.



SYNCHRONOUS MOTOR GENERATOR SET IN THE TUNNEL SUB-STATION OF THE PITTSBURGH RAILWAYS CO.

In addition to the set illustrated, there are two similar additional Westinghouse synchronous motor-generator sets in the station, each having a capacity of 1000 kw.

AMONG THE FIRST PUBLIC buildings to employ air cooling methods for the comfort of its occupants is the new $150,000 Baptist church just completed in Oaklahoma City. The seating capacity is 2,000 and the building has a complete lighting, heating and ventilating plant by means of which the entire air in the church is changed 4 times an hour. During the summer incoming air will be passed over ice to maintain a comfortable atmosphere.

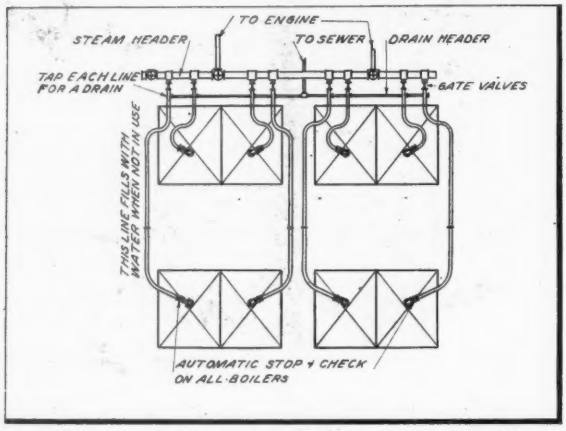
LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

HIGH-PRESSURE PIPING

IN the modern steam plant of today high pressures are carried. These pressures are from 165 to 200 lb. pressure. Precautions should be taken in the design and operation to avoid water hammers. A water hammer is probably next to a boiler explosion in its destructive force. In the laying out of the piping a competent person had better be employed in order that no mistakes be made. The piping, fittings, etc., are sufficiently strong to care for the pressures, but will not care for water hammers in the lines. A person such as a steam fitter may lay out a line in which the material and workmanship may be first class, yet be dangerous when turned over to the operating force.

One of the first things to be considered is the layout; next, the material, and last, the workmanship. Failure to observe good practice or workmanship in


TO ENGINE
STEAM HEADER
TO SEWER
DRAIN HEADER
TAP EACH LINE FOR A DRAIN
GATE VALVES
THIS LINE FILLS WITH WATER WHEN NOT IN USE
AUTOMATIC STOP & CHECK ON ALL BOILERS

METHOD OF DRAINING BOILER CONNECTIONS TO HEADER

either will result sooner or later in some disastrous failure. For high pressures, fittings and pipings should be and generally are used to correspond, but I have frequently seen standard fittings in service when they had better be in a scrap pile.

One of the first things to look after and to be avoided is pockets in the pipe lines. Where they can not be avoided, drain them by connecting them up to a trap. And further, see that the trap is kept in good working order. No steam connections should be made unless the connections are line in line and no strain thrown upon the fittings. Further provisions should be made to care for the expansions in the line. In anchoring a line it should not be so rigid but that there will be sufficient room to care for the expansion.

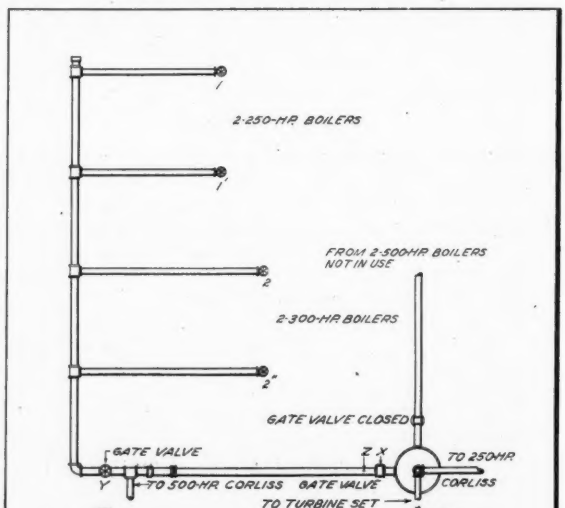
I am inclosing a sketch of a steam line which has caused considerable trouble from water hammer and show how it was taken care of and future troubles avoided. The header line, as well as the branch lines, was drained by traps. When a boiler was off water would collect in boiler branch lines, and in cutting in a boiler, water hammer was started, on one occasion a very disastrous hammer caused the failure of a valve and the whole plant was out of service. To avoid such accidents in the future a ½-in. drain line was tapped into these lines. These lines were connected to a drain header line passing beneath the lines which is always open to the sewer. When a boiler is off this ½-in. drain line is opened and remains so until the boiler is back on the header, when the ½-in. valve is closed.

This avoids all danger from water collecting in the line and no further trouble has been experienced.

W. J. Maxwell.

EXPERIENCE WITH WATER HAMMER

OLD memories often return with renewed vigor and a recent conversation with a brother engineer brought this one to the writer's mind. Accompanying are 2 views of the piping system of a plant where the writer was once employed. Owing to the absence of a drip or bleeder, as shown, a water hammer gave no end of trouble. It happened this way: the pipe fitters were at work on the turbine feeder having the valve X closed. As the plant was operated only during the day they did not "cut in" the receiver after they had finished.



PLAN AND ELEVATION OF PIPING WHICH CAUSED WATER HAMMER

When I came on duty about 6:30 a.m. and found the steam cut off I opened the by-pass through the 500-hp. Corliss and then noticed the lack of a bleeder on the lower main pipe (this was the writer's first day in the plant).

Upon further examination I noticed the valve X, a rising stem gate valve, hung upside down in such a way that the gates closed from the bottom upward. With no small amount of caution I "cracked" that valve a bit and—well, the pipe line started to "crack" also.

Imagine the predicament, if you will! 110 lb. of steam and a very wholesome water hammer at work within that lower main line. Every shock of that slug of water would shake the whole line, receiver and all.

Hastily looking along the line toward the boilers I noticed the valve Y on the higher line. I ran upon the running board and began trying to close that valve when the night fireman told me it wouldn't work, anyhow, so the master mechanic (chief engineer, and so forth) had had the gates taken out and the bonnet replaced. Of course that is another nice feature of the experience, but it didn't lessen the water hammer.

Then I called the night fireman with me and we cut out each boiler from the main separately with the valves 1, 1′, 2 and 2″. When the line pressure dropped to 0 I opened that inverted valve X and then cautiously cut the first 300-hp. unit back onto the main and receiver. Then as fast as possible the other 3 were cut in.

Perhaps this isn't much of an experience but it left a deep impression upon the writer's mind. Aside from a few leaks no harm resulted and good ultimately resulted from it, in that a new gate valve was placed at Y, a bleeder along the lower main line toward the boilers as at Z, and a chief engineer who knew enough to pipe the drip from the receiver into a water heater near by rather than into the sewer (as shown). Of course the chief knew a few other things, too—many of which he helped the writer to learn. We all make mistakes, but how odd they seem when the other fellow has the racket.

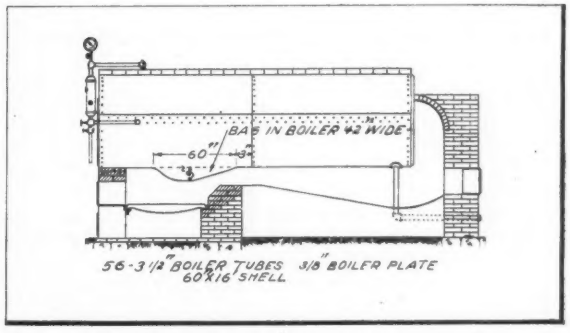
I. M. Coming.

OIL IN BOILER CAUSES DANGEROUS BAG

HEREWITH is a sketch of a bagged boiler sheet which I consider somewhat out of the ordinary, in regard to the size of the bag, and also the cause. Before giving descriptions, etc., will say that I was not engineer at the plant at the time of burning the boiler, which happened Feb. 12, 1912, but took charge of plant Feb. 27. The boiler is a return tubular and is 60 in. in diameter and 16 ft. long and has 56 3½-in. tubes, and the bottom is made up of 2 8-ft. sheets, extending half way up on each side making 2 double riveted longitudinal seams and one girth seam, the bag was in the half sheet directly over the grate and commenced about 3-in. from the girth seam and extended toward the front end of the boiler 60 in. and was 42 in. wide and dropped down 9 in. as per sketch.

And as to cause, will say there was no scale in the boiler, but the plate was covered with about ⅛ in. of baked cylinder oil, as there is an old return tubular boiler that they are using as an open heater and by letting the water get low in the heater, the cylinder oil would get into the boilers, and as near as I can find out there was plenty of water in the boiler at all times. On Monday morning, Feb. 12, after the engineer had started the engine and gone back to the boiler to throw on coal, as the engineer does his own firing, he discovered the bag and at that time his water glass was nearly full of water and 60 lb. steam pressure on the boiler, and as there is no other apparent cause the oil must have caused the bag. The plant has 2 boilers both the same size, but only one boiler is used at a time.

At the time I took charge, the boiler makers were just repairing the burnt boiler and were putting on a new half sheet, and the burnt sheet was lying in the yard. The other boiler was in operation and it made me rather uneasy to know that I was firing a boiler coated with oil, as one boiler was coated with oil and the other must be, and also no chance to take the boiler off the line to clean it until the other was ready for use, but I managed to keep the heater full of water and let some run out of and overflow so as to remove



BOILER BAGGED DUE TO OIL IN FEED WATER

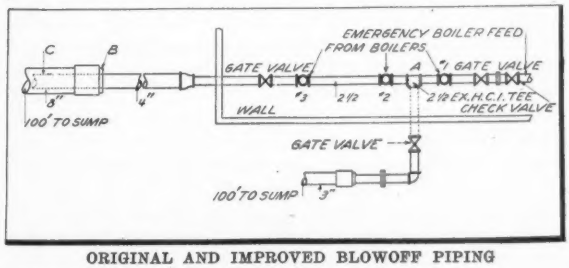
the oil from the surface of the water in the heater, and thereby keep any more oil from getting into the boilers, and I commenced using soda ash 2 quarts a day for the first 10 days, then every other day for the next 10 days, and twice a week after that, and by frequently blowing down and washing out the boiler, I have got rid of all the oil that was in the boilers, and the boilers are in nice shape.

The uneasy feeling has left me, which is quite a relief. This shows what oil will do to a boiler, and also gives a remedy to the engineer who should happen to get any oil into his boilers. Wm. Debo.

FAILURE OF BLOWOFF CONNECTIONS AND REMEDY

IN our plant equipment we have 3 250-hp. horizontal water tube boilers, the blowoff connections being made into the top of the main blowoff line, as shown by 1, 2 and 3 in the sketch.

When first installed the line was put in as shown by the dotted lines from the tee at A, an elbow being placed at 3 instead of the tee, going outside the building about 4 ft. to an ell. The 2½-in. line was then raised to 3 in. for a distance of about 100 ft., where it discharged into an open sump hole. The expansion of the 3-in. line threw too much steam on the 2½-in. tee at A,



ORIGINAL AND IMPROVED BLOWOFF PIPING

which caused 2 of them to fail, although extra care was taken when opening the cocks. No one was injured, as the parts held in place until the cocks were closed in each case, the boiler pressure being 160 lb. at one time and 140 lb. at the other.

The main line was then changed to go out of the building in a straight line, as shown, the 2½-in. line being

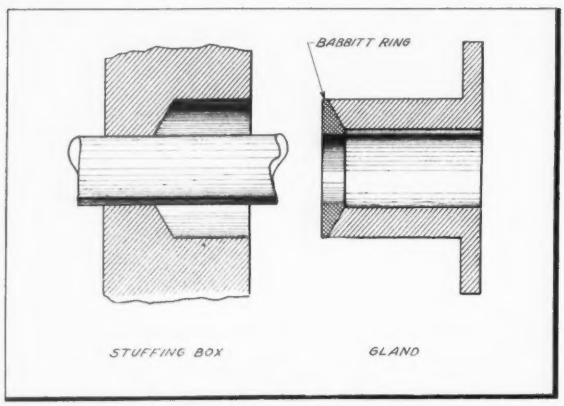
raised to 4 in. after leaving the room, then raised again to 8 in. by the use of a bushing at B, which has the 4-in. side turned out enough to make a sliding fit over the 4-in. pipe which extends into the 8-in. pipe for about 12 ft., as shown by the dotted lines at C, making an expansion joint which eliminates the strains on the blowoff connections. No packing is used, but the joint does not leak, owing to the syphon effect of the steam.

B. F. Hartley.

OVERCOMING TROUBLES WITH PUMPS

I RECENTLY had a great deal of trouble keeping the packing in the stuffing box on a badly scored piston rod. This box had a taper bottom and I thought at first it would work better if the bottom was square, so I had a babbitt ring made to fit the taper and squared up the bottom of the stuffing box. I was using a good diagonal ring packing and felt sure the trouble was not here. I installed this ring one night after I shut down and filled the box with new packing and the next morning when I started up it acted worse than ever.

I kept at work on it for 2 days and after I shut down the second night I determined to remove the ring. I did so and packed the box again, when the idea came to me that as the bore of the gland was about ¼ in. larger than the rod that might cause my trouble. Now, this gland was countersunk or tapered just opposite to the bottom of the stuffing box, therefore I left out one ring of packing and in its place I put the babbitt ring flat side to the packing and taper side to the gland. I put the gland back in place and as the nuts on the retaining studs kept working loose I placed



LOCATION OF BABBITT RING ON GLAND

a spring washer between the main nut and the lock nut. The next morning I started up and have had no further trouble with leaky stuffing box or loose nuts.

I called to see a friend of mine at his plant in a cotton mill. The company was working with small capital and trying to build up a business from the ruins of its predecessor. Capital being limited, it was like pulling teeth to get anything in the line of supplies not absolutely necessary.

It so happened that the lining of the water cylinder in one of the boiler-feed pumps wore out entirely and my friend tried in vain to get the firm to buy a new lining. Finally he became desperate and took a short piece of 4-in. brass pipe and annealed it and put it in for a lining. He found it a trifle too small to fit the plungers, so turned them down to fit, then put the pump together and when started up it worked fine.

W. E. Chandler.

TAKING EXAMINATIONS FOR LICENSE

I HAD never thrown a shovel of coal into a furnace until a week before I took my first examination which I passed, receiving a second-class fireman's license. I am now holding a first-class fireman's license and under the examinations given in Massachusetts I feel that I have done exceedingly well, having been in the business only 3 yr, compared to what others I know have done.

Examinations in Massachusetts are rather difficult in the opinion of many men; I always think so when I first leave the examiner after being turned down, but after thinking over the questions at leisure they all seem to be simple, little things which I think any power plant man should know. Questions are asked in regard to things which a man might never see or have to contend with and again things that might come up before him at any time.

After passing my first examination the examiner was very accommodating and gave me quite a little information. He told me there was no use of ever applying for a first-class fireman's license for if I could pass for this I could pass for a third-class engineer's license. I went before him twice after this for a first-class fireman's license but he turned me down both times. I know the questions I failed to answer were questions I should have known and I never blamed the examiner.

Six months ago I applied for an extra first-class fireman's license, but I was only able to obtain a first-class. I am in a different district now and therefore had to go before a different examiner. This man told me if I could pass for an extra first-class fireman I could pass for a second-class engineer. He never offered to give me a third-class engineer's license though.

Now if a man has to pass the same examination for fireman's licenses as for engineer's, what is the use of having firemen's licenses, why not have them all engineer's licenses? I would rather have an engineer's license anytime.

I am going to take him at his word, however, and soon apply for a second-class engineer's license.

Edward A. Warner.

THEY WILL LEARN—PERHAPS

IN a large paper mill the boilers were all connected, the pops were all screwed down but one, the engineer happened to look at his gage one Sunday afternoon, and seeing that it registered 155 lb. where 120 was the limit allowed, hurried for the boiler room, 2 boilers including the one that did the "pop act" were being cleaned. The head fireman with a helper were tending to that and another helper was firing the other 3, and working hard, when the engineer asked him what he was trying to do, he replied, "I am going to make them pop if I have to go to 250 lb."

A motor was installed, which was a mystery to most of the men. One night a belt ran off and as it had to be lifted on some men were called from the beater room to help, they were using the engine starting bar, and one said to the superintendent, "What's the matter, Bill, is she on the center."

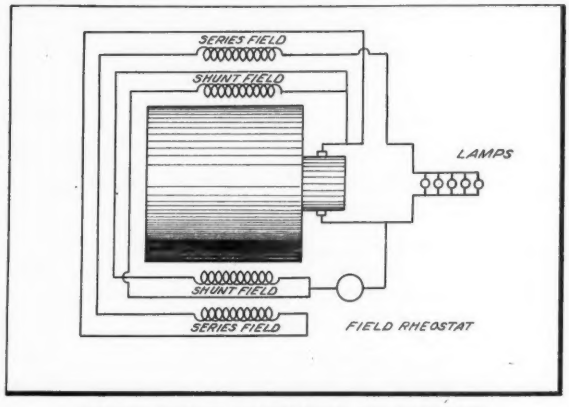
A new fireman left his fur coat in the boiler room and upon being told it would get all soot, said, "you can't hurt that coat, why I fired a gasoline engine all last winter with that coat on." V. C. Wood.

CHANGING 220-VOLT MOTOR INTO 110-VOLT GENERATOR

IN the April 15 number of Practical Engineer, J. H. asks concerning the use of a 3-hp. direct current motor as a generator. While the answer given will serve the purpose very well, we think the following arrangement would suit his case better.

Since he wishes to use 110-volt lamps, and as 7 lamps are all that he needs, we would advise that he convert his 220-volt motor into a 110-volt generator.

This can be done by arranging the shunt field connections so that the current will flow through the coils in 2 circuits. That is, if his machine is a 2-pole motor, instead of connecting the field coils in series (as he will find them), connect them in parallel, being careful not to reverse the polarity of one of the coils. Then arrange the pulleys on his engine and generator so that the generator will run at approximately half the speed it did as a 220-volt motor.



SHUNT FIELDS CONNECTED IN PARALLEL

In case his machine is compound wound it will be necessary to reverse the series coils. But they should be left in series with each other.

He will then have a 110-volt generator that will work perfectly and with practically the same efficiency that it would have if run as a 220-volt generator.

His generator would have a capacity of approximately 20 16-candlepower lamps.

He will also be able to run just 7 lamps or any number for 1 to 20 or their equivalent in larger or smaller lamps without regard as to what kind of lamp he has in some other socket, which would not be the case if he would have 2 lamps in series, as the lamps in series would have to have the same amount of resistance. A. A. S.

TESTING ENGINE ALINEMENT

HEREWITH is presented a way of testing an engine for alinement from the flywheel which I think is more accurate than getting it from the crank pin, the method explained in a recent number.

Center the line in the cylinder and stuffing box in the usual way, then make a mark on the rim of the flywheel. Take a straight edge and level the mark on the flywheel with the line as shown in Fig. 1. Now measure the distance from the mark on the flywheel to the line, then roll the flywheel over ½ of a revolution and level the same mark with the line again, now measure from the mark on the flywheel to the line. If the 2 measurements are the same the shaft is at right angles to the center line of the engine.

In a like manner it may be determined if the shaft is level or not. Make a mark on the edge of the rim of the flywheel, drop a plumb line close to the flywheel and as near the center of its diameter as possible, roll the flywheel until the mark is directly opposite the plumb line, then measure the distance

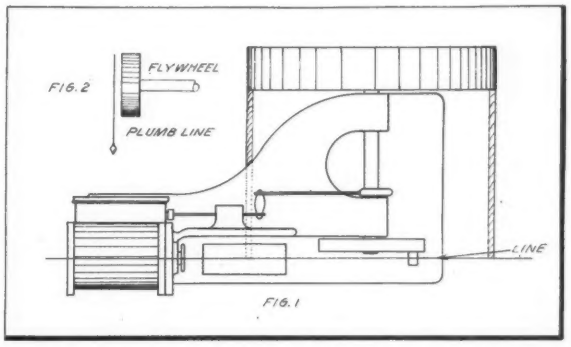


FIG. 1. TESTING ALINEMENT OF SHAFT WITH CYLINDER
FIG. 2. TESTING SHAFT FOR LEVEL

from the mark to the line. Turn the flywheel over ½ of a revolution and measure from the mark to the line again. If these 2 measurements are the same the shaft is level. Wm. Carpenter.

DOES THE INDICATOR LIE?

I WAS much interested in the article under the above caption; it brought to my mind some of my own experience with the indicator. I have found that a single eccentric Corliss engine with the steam valves lapped ¼ in., with wrist plate in the center and valves hooked up, will, according to my 2 indicators of different makes, both of which are guaranteed to be correct, cut off at

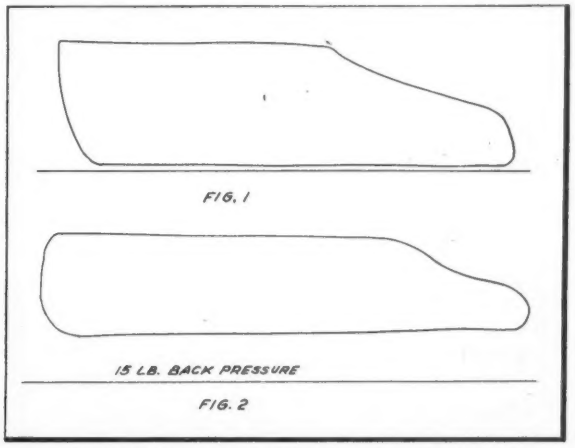


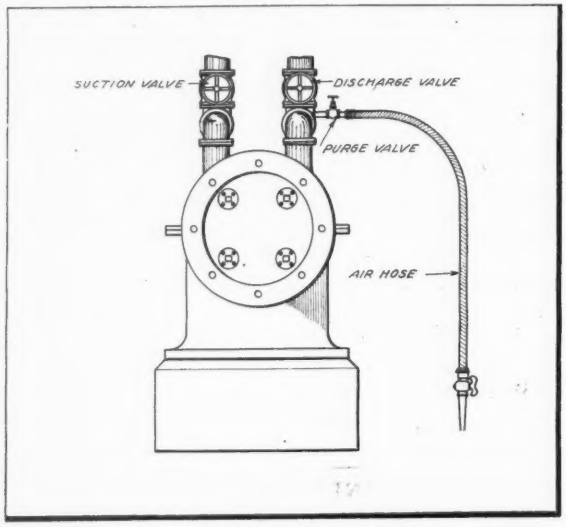
FIG. 1. CARD FROM CORLISS ENGINE RUNNING SINGLE ACTING
FIG. 2. EXCESSIVE BACK PRESSURE CAUSES ¾ CUTOFF

⅝, and another engine single eccentric Corliss cut off at ¾ stroke. In the first case I fixed one end so it would not pick up, making one end do all the work, giving card, Fig. 1, which when measured gives a m.e.p. equal to both ends when running naturally. In the case of Fig. 2 card on another Corliss engine I added back pressure until the cutoff took place at ¾ stroke.

The same results have been obtained from a Corliss single eccentric. From our best theoretical knowledge of the principles of valve setting this cutoff beyond ½ stroke is out of all reason for single eccentric, yet this is a case where theory and practice apparently do not agree, or is the indicator lying? Try it and let us hear your result. A. C. Waldron.

COMPRESSING AIR WITH AMMONIA COMPRESSOR

THE accompanying sketch shows an ammonia compressor used to compress air for cleaning the dust and dirt from motors when an air compressor is not at hand. Open the discharge stop valve and pump out



CONNECTIONS TO AMMONIA COMPRESSORS WHEN COMPRESSING AIR

what ammonia there might be in the cylinder, then open the purge valve on the discharge arm of the compressor and then close the discharge stop valve. Take out the plug in the suction screen or arm and do the cleaning as you would with any source.

Martin McGerry.

AN IMPROVISED DRILL PRESS

IN using a breast drill it is almost impossible to hold the drill true, and where a number of holes are to be drilled they are very apt to be at varying angles. In using small bits it is also very difficult to prevent them from bending or breaking, and when using large bits the task is very slow as well as laborious.

In order to overcome these difficulties the writer constructed the device shown attached to the work bench in the illustration, to use in connection with an ordinary breast drill. The frame work is made of hard pine. The piece marked A is hollowed out at its outer end to receive the stationary or holding handle of the drill frame, the bolt bent at right angles clamping it in place.

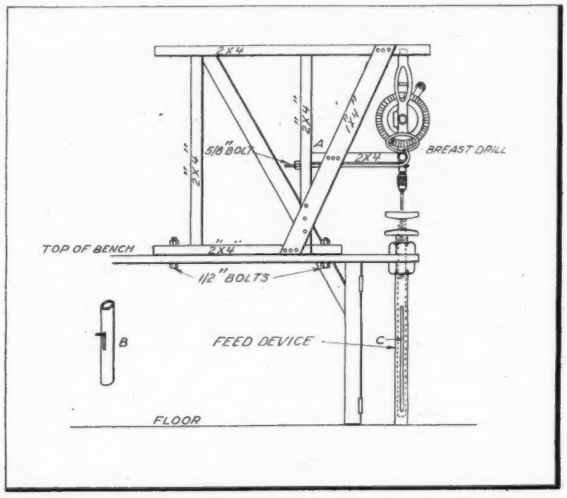
The feeding device consists of a piece of 1¼-in. pipe, the upper end of which extends through a hole in one corner of the work bench, and secured by the 2 lock nuts as shown.

In this pipe is placed a piece of 1-in. pipe, the upper portion of which is threaded a distance equal to the extreme lift, or the amount of the supporting head may be raised. One-half of a 1-in. flange union is secured to the upper end of this pipe for a supporting head, the other half of the union is placed below and free to turn on the threads.

This lower half of the union is recessed out on its under side to produce a snug fit over the end of the 1¼-in. pipe which extends through the lock nut for this purpose.

On the lower end of the 1-in. pipe is a lip cut and turned outwards as shown at B, which slides in the slot cut in the larger pipe as shown at C. This prevents the smaller pipe from turning.

By turning the lower half of the union the supporting head may be raised or lowered as desired.



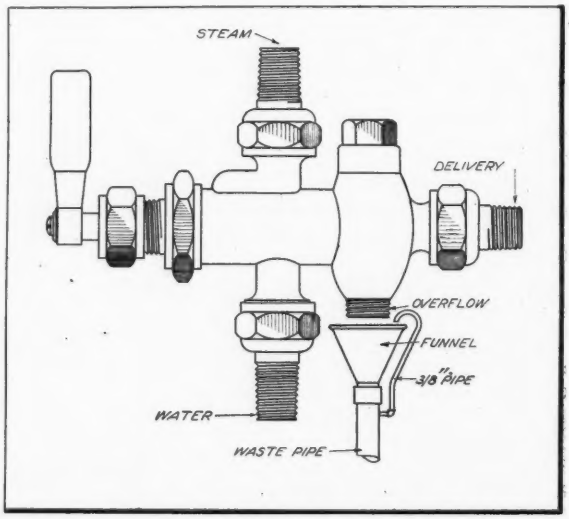
HANDY DRILL PRESS

This frame could be placed on the wall or a column if desired, and in the absence of a regular drill press it serves the purpose very well up to bit sizes within its range.

Jos. Stewart.

INJECTOR OVERFLOW PIPING

HEREWITH is a sketch which shows a method which I use to prevent the funnels on injector overflow pipes from running over and making a puddle on the floor when the injector is started. Place



INJECTOR OVERFLOW PIPING SHOWING PIPE TO REMOVE ENTRAINED AIR

a ⅜-in. pipe into the waste pipe about 3 in. below the funnel as shown in the sketch. This allows all the entrained air to escape from the pipe which is the cause of the trouble.

Richard Howarth.

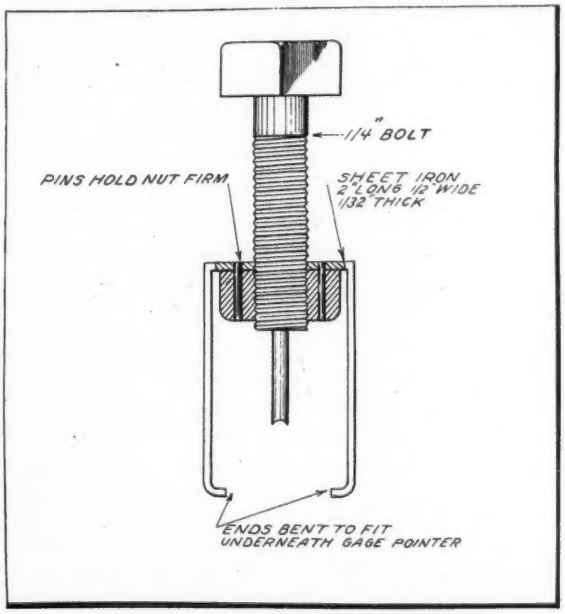
Successful Kinks From The Plant

For Saving Time, Work and Trouble

Removing Gage Pointer

THE following explains how I constructed an instrument for removing the pointer from a steam gage for adjustment. It is easily made and fits any size pointer.

I took a ¼ in. machine bolt about 1½ in. long. I made a center punch mark at the end and then filed the end of the bolt down to about 1/16 in. in diameter



APPLIANCE FOR REMOVING GAGE POINTER

for about ½ in. Then I took a piece of sheet iron 1/32 in. thick ,2 in. long and ½ in. wide, drilled a ¼-in. hole at the middle and then shaped it to the form shown in the sketch. I then passed the bolt in the hole in the sheet iron, screwed a ¼-in. nut on the bolt and the instrument was completed.

To use the instrument place the bent ends of the piece of sheet iron underneath the pointer and the pointed end of the instrument on the end of the pointer spindle and screw down on the head of the bolt until the pointer is removed. The center punch mark at the end of the bolt prevents the instrument from slipping off the pointer spindle. Frederick M. Perras.

Some Ideas for the Boiler Room

IT frequently happens that piping is so far above the floor that the valves cannot be reached without climbing a ladder or providing a permanent platform. This inconvenience is overcome by providing a chain wheel on the valve in place of the hand wheel. In Fig. 1 is shown the arrangement I have employed, the wheel and chain being taken from an old harvesting machine.

The principle of the steam gage is used in the damper regulator shown in Fig. 2, the tube, however, is inverted in order to keep it filled with water. The dotted position is that taken when no pressure is on the boiler. Regulation can be adjusted to a nicety by means of the spring and turnbuckle.

Some 3 yr. ago the back arch of my boiler gave considerable trouble, so I devised the one illustrated

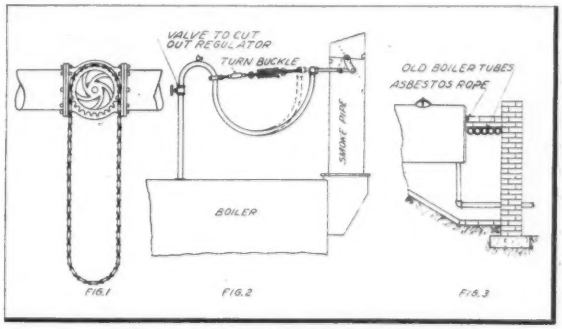


FIG. 1. VALVE OPERATED BY CHAIN
FIG. 2. HOME-MADE DAMPER REGULATOR
FIG. 3. BOILER ARCH SUPPORTED BY OLD BOILER TUBES

in Fig. 3. Old boiler tubes were placed close together and used to support 2 layers of brick. To allow for the expansion of the boiler an asbestos rope was placed between the brick and the boiler which had sufficient give to provide for expansion, at the same time prevent inleakage of air. The arch is still in service. Chas. Fenwick.

Filling Crack in Flue Sheet

ONE of the best and simplest ways I know to fix cracks in a flue sheet is to bore a number of small holes, say ⅜ in., in the crack, tap them to make a good thread and screw short copper plugs into them. The plugs can be nitched in a lathe, and when the plug has been screwed in the thickness of the sheet it can be cut off with a sharp cold chisel. Then with a calking tool rivet the plugs so as to fill the crack entirely. C. Husted.

Lubricator Kinks

WHEN inferior grades of lubricator oil clog the sight feed glass of the lubricator, preventing the appearance of drops so as to regulate the flow of oil, the ordinary methods may be used in keeping it clear. One way is to cut some very fine shavings of laundry soap and drop them along with the oil. As the lubricator becomes nearly filled with oil just before replacing the filling plug, these will dissolve as soon as lubricator becomes nearly empty.

Another method is by unscrewing the plug at the top of sight feed glass and putting in a very small quantity of salt which will also help to keep the glass free from oil. L. A. Danner.

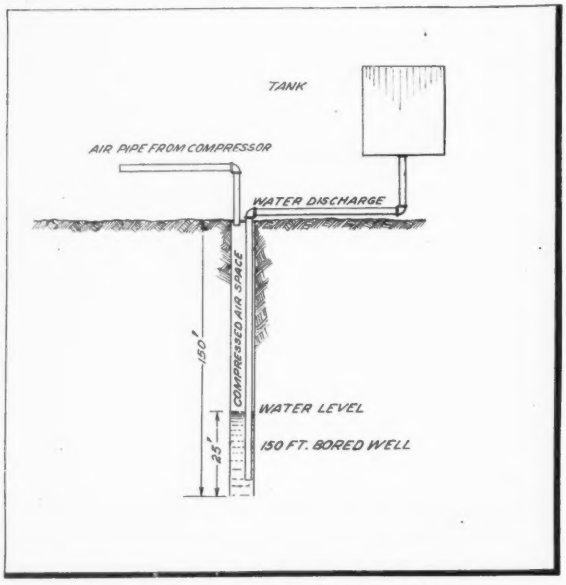
Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Pumping with Compressed Air

I WOULD like to ask why compressed air cannot be used to raise water from a 150 ft. drilled well, in the manner shown by the accompanying sketch, which explains itself. N. F. S.

A. In regard to the proposition which you make for pumping water from a well by the use of compressed air, sealing up the well and forcing air in on top of the water, the only difficulty is that you will stop all flow of the water into the well from the surrounding earth. You must remember that in order to have a well furnish a continuous supply, water must come into it, and it flows in by gravity from the earth around, either through the body of the earth or through fissures in the rock.



AIR LIFT WELL THAT FAILS TO WORK

When you put on sufficient air pressure to force the water which is already in the well up through a tube and deliver it at a height above the ground level, you will have sufficient air pressure in the well to prevent any more water flowing in. You could probably force out what water there was in the well this way and some of it would flow up the delivery pipe rather than to be forced back through the soil, but after you had once emptied the well you would have to shut down and wait for it to fill up again and in order to pump out the water you would have to fill the 125 ft. of empty casing with air every time you emptied the well, which would be a rather inefficient proposition. A. L. R.

Operating Costs

SHOULD like to know the cost of operating a 300-hp. boiler plant. The boilers will furnish steam for 1 direct-connected 125-hp. engine to 75-kw. generator. The balance of the boiler capacity will be used for air and vacuum pumps, also for steam for producers.

I would like to know what the difference in cost of operation, if any, between using a steam engine or gas engine to run the 75-kw. generator, or how the cost of operation of either one compares with the cost of current furnished by the central station at 2.5 cents a kw. hr. I should like to ask the number of pounds of water evaporated per horsepower, and the amount of coal used in a modern plant of about 300 hp. W. R.

A. Let us take up your engine performances first. We will consider economical steam pressures. If you are going to carry 100 lb. gage pressure, you will want simple non-condensing engines. If greater economy is desired, then you may want 150 lb. gage pressure and use compound engines, either condensing or non-condensing. The determining factor in choosing between condensing and non-condensing will be the use of exhaust steam. If you use exhaust steam, non-condensing operation will be what you want. You may obtain the following results:

Non-condensing, simple high speed engine, 100 lb. equals 32 lb. per i.h.p. hr. Non-condensing, compound high speed engine, 150 lb. equals 25 lb. per i.h.p. hr. Condensing, compound high speed engine, 100 lb. equals 21 lb. per i.h.p. hr.

You do not speak of steam pressures in your letter, so your attention is called to the above data first.

For the purpose of comparison we will take: 1. A simple high speed engine non-condensing. 2. A compound high speed engine non-condensing. 3. A gas engine unit.

With each of these three types we will figure the yearly cost of operation, considering these items alone:

1. Fixed charges equals interest on investment and depreciation. 2. Operating cost equals fuel costs.

We will assume a fuel at $3.00 per ton of 2240 lb., 10 hr. day, 300 days per yr., 125 i.h.p., 6 lb. evaporation, and we get the following results:

1. $\frac{32\times125\times10\times300\times3.00}{6\times2240}$ equals $2,678.00 yearly cost of fuel; 12 per cent of $1,875, first cost, equals $225.00 interest, depreciation. $2,678 plus $225 equals $2,903, yearly cost of operation.

2. $\frac{25\times125\times10\times300\times3.00}{6\times2240}$ equals $2,092.00, yearly cost of fuel; 12 per cent of $3,125, first cost, equals $375.00 interest, depreciation. $2,092 plus $375 equals $2,467, yearly cost of operation.

3. $125\times1.5\times3000\times.001339$ equals $753.18, yearly cost of fuel for gas engine. 12 percent of $5,250, first

cost of gas engine, equals $630.00 interest, depreciation. $753 plus $630 equals $1383.00, yearly cost of operation.

As will be noted, these calculation do not take into account, wages, oil, upkeep, and depreciation on any other part of the plant. This will, however, give a comparative cost between steam engines with two boiler pressures and the best gas engine practice.

The first cost of the engine are quotation prices on each of the types named. The amount of fuel per hp. hr. is respectively 5.3, 4.1 and 1.5 lbs.

If you wish to compare the cost per kw. including the above yearly costs, you will need to add the fixed charges of the generator installations. We will have to assume also that the r.p.m. of the respective machines are the same.

16 × 125 equals $2,000 × .12 equals $240.00 added to each of the yearly costs given, will give you the comparative yearly cost in each case of producing 75 kw.

Theoretically, this would give a cost per kw. hr. respectively, 1.3, 1.2 and .7 cents. In practice, when taking the other expenses and load factor into consideration, it would be nearer 5., 4., and 2. cents per kw. hr., which you would compare with central station rate of 2½ cents per kw.

The gas engine or central station either will not give you exhaust steam, which should be credited to the cost per kw. production of the steam driven unit.

Another important factor in some plants, to be considered when choosing between steam and gas, is the fact that gas engines cannot be depended on for an overload above rated capacity. Steam prime movers can be guaranteed to carry continuously an overload of 2 per cent and 50 per cent for stated periods of time.

Now, as to the fuel cost of operating a 300-hp. boiler plant. We will take the same rate of evaporation used in above examples. One boiler hp. equals the evaporation of 30 lb. of water under certain conditions. 30 ÷ 6 equals 5 lb. of coal per b.h.p. hr. 300 × 5 × 3000 × .001339 equals $6,025.50 per year (of 300 10-hr. days) for fuel at $3.00 per long ton (2240 lb.). H. E. Collins.

Steam Engine Questions

IS it the usual practice in the construction of compound engines to have the high-pressure crank lead the low-pressure crank by one-quarter stroke (90 deg.)? Can a vertical engine of this type be reversed with equal results, in which case the low-pressure pin will lead by 90 deg.?

A. This will depend upon the type of engine. If the engine is equipped with a receiver correctly proportioned, and cutoff occurs in the l.p. cylinder at a point equal to the volume of the h.p. cylinder, there will be a constant pressure maintained in the receiver equal to the terminal pressure in the h.p. cylinder.

A cross compound engine so equipped, and having a reversing valve gear could be run in the opposite direction, for the reason that the l.p. cylinder, even though the crank be 90 deg. ahead of the h.p. crank, will, after the engine has made a few revolutions in the reverse direction, have a constant supply of steam in the receiver to draw upon.

The receiver space should be from 1 to 1.5 times the capacity of the h.p. cylinder when the cranks are set at an angle of from 90 to 120 deg. apart.

C. F. Swingle.

Combustion Problem

WILL you kindly let me know what, if any, economy there would be in changing from anthracite to bituminous coal, the conditions of plant remaining the same?

Please give me any information or data that will enable me to formulate a report on the advantages or disadvantages of either. J. F. O'D.

A. Burning of bituminous coal instead of anthracite for conditions that have been designed for anthracite, has disadvantages which may outweigh the advantages of economy, and even the advantage of economy may, by the conditions imposed, be reduced to zero.

If, however, there is sufficient draft and combustion space, with not too close proximity to the heating surface, bituminous coal can be burned with an economy nearly proportional to the ratio of heat units that can be bought for a dollar. For example, a ton of hard coal having 14,000 B.t.u. per lb., costing $4.00 per ton, will, with 7 per cent efficiency, give (14,000 × 2,000 × .70) ÷ 400 = 4900 B.t.u. for 1 cent; a ton of bituminous coal carrying 13,000 B.t.u. per lb., costing $3.00 per ton, with 60 per cent efficiency, will give (14,000 × 2,000 × .60) ÷ 300 = 5200 B.t.u. for 1 cent. The relative efficiencies then will be 49 to 52. The advantages of anthracite coal are greater; cleanliness in handling, somewhat less storage space, somewhat less labor in firing, and probable higher efficiency of boiler for conditions designed for anthracite.

Bituminous coal can be burned in much larger quantities per sq. ft. of grate than anthracite; with .3 in. draft over the fire anthracite pea would burn at about 15 lb. per sq. ft., and bituminous run of mine about 30 lb. with proper grates. To get the exact data for the plant, it would be well to run tests of several days each with anthracite, and then with bituminous, weighing carefully the coal, and measuring the amount of water evaporated per lb. of coal, recording the feed water temperature and the boiler pressure, securing from the coal men the B.t.u. contained in each coal, and with this data you will be able to compare conditions as indicated above.

P. M. Chamberlain.

Type of Condenser

WILL you please give me your opinion as to what type and make of steam condenser is best suited to our steam plant?

We have 2 150-hp., high-pressure, tubular boilers working at 150-lb. steam pressure, 1 18 in. by 30 in. Murray Corliss double ported valves and 2 eccentrics engine making 117 r.p.m., and a 300-hp. National heater. We run with water power 7 months, and the rest of the year with steam. We carry from 100 lb. to 150 lb. steam pressure, according to the load which runs from no load to 300 hp.. We have plenty of water at 60 deg. F., 97 lb. pressure, for condensation purposes.

What would be a conservative estimate of the amount of fuel saved by putting in a condenser? Our average load is 150 kw. C. W. W.

A. We take from your letter that while you do not have enough water to run your plant by water power but 7 months in the year, that you still have enough left during the dry season for condensing purposes while operating the plant by means of the steam engine, and that it can be had under a constant head of about 97 lb. pressure and a temperature of 60 deg.

So no matter which type of condensing apparatus that you select, you will not be to any expense to handle the condensing water. This brings the proposition down to 2 methods, which you will have to decide for yourself.

First, you can install either a jet or a syphon condenser which requires no pump or other apparatus to maintain continuous operation. Under ordinary conditions, however, these types do not maintain as high a vacuum as a surface condenser will by about 4 in. The boiler feed pump can take its supply from the hotwell where it will take up about 4 or 5 per cent of distilled water, the remainder, of course, being condensing water. If the condensing water is quite pure and will not cause any great amount of incrustation in the boilers, this would be the cheapest, we believe, under the conditions which you have.

Second, you can install a surface condenser, using the supply which you have under pressure for circulating water, and install a small independent air pump which will maintain a vacuum of 27 to 28 in., and at the same time save all the distilled water to be returned to the boiler. The air pump can be arranged to discharge into a receiver or reservoir from which the feed pump obtains its supply. In this way you will have practically pure water for your boiler at all times.

With either method you can still use your National feed water heater as usual by locating the heater between the engine and the condenser, but be sure that there are no leaks or poor joints in the steam space, for these will impair the efficiency of the vacuum.

An automatic relief valve should be arranged with either system to permit free exhaust to the atmosphere in case of interruption of the condensing apparatus.

We believe that under the conditions which you mention that the saving would be from 18 to 20 per cent in fuel by installing a condensing system.

G. H. Wallace.

Meter Reading

ABOUT 3 weeks ago we had a 10-hp. motor connected to a 26-in. planer; it has run perhaps ⅔ of this time. The bill came in today figured as follows:

Kw. hr. 203; constant 10; total kw. hr. 2030; hp. hr. 2722; rate 2½ cents per hp. hr.; total $68.05.

I would like to know how this is figured to get this result. Is it correct?

A. So far as the reading of the meter is concerned, your bill figures up correctly, but if you have any doubts about using so much current would suggest that you have your meter tested.

We take it that your meter reads in kilowatt hours, and when your bill is rendered this is reduced to horsepower hours. There are 1,000 watts in a kilowatt, and 746 watts in an electrical horsepower, and to reduce one to the other it is only necessary to use the simple proportion, 1000 : 746 :: X : 2030, which equals 2721+, or approximately corresponding with the figures you give.

N. G. M.

Back Pressure on Engine; Operation of Exhausters

WHY is quicksilver used in a U gage instead of water, as for gas pressure?

Explain back pressure. How many kinds other than back pressure on an engine piston?

How do you find the hp. of an engine from work done by a centrifugal exhauster?

If you have two exhausters on the same line, why will they not raise pressure double that of one? Will they throw twice the amount of gas or not? F. T.

A. Back pressure is the pressure against a piston on the exhaust side, tending to oppose the motion of the piston. Besides this there is forward pressure, which is the pressure exerted by the live steam to force the piston in the direction it is moving. The difference between the two at any instant is the effective pressure, and the mean effective pressure is the average difference through a stroke.

The method of finding the horsepower of an engine from the work done by a centrifugal exhauster depends on how that work is given. If you know the number of cubic feet of air handled per minute and the pressure per square foot against which it is handled, then the volume in cubic feet times the pressure per square foot will give you the foot pounds of work done per minute and this divided by 33,000 will give you the horsepower done on the gases by the exhauster. Allowing, then, for the friction of the exhauster, the friction of the engine and the loss in transmission, which might have an efficiency all together of 50 to 60 per cent, you could find the horsepower required in the engine cylinder. If you have two exhausters, one discharging into the other, so that they run in series or tandem, the pressure for the 2 should be twice that for one. If the 2 exhausters run in parallel, that is, both drawing from the same pipe and discharging into the same pipe, the pressure would be the same as for a single exhauster, but the amount of gases handled would be twice that for the single apparatus.

The reason for using quicksilver in the U tube for measuring condenser pressure is simply because of its extra weight. A water gage might be used, but it would have to be 30 ft. high instead of 30 in. high, which, as you will realize, would be rather inconvenient.

A. L. R.

Ice Plant Questions

WHAT is the approximate size of an ice plant that would supply a town of 1500?

A. Approximate size of an ice plant for a town of 1500 inhabitants would depend a great deal on the surrounding territory; but we should consider for ordinary conditions that a 12 to 15 ton plant would be ample for a city of this size. This would allow you to handle considerable outside territory.

2. What would be the approximate cost of the plant.

The approximate cost of a plant of this size would be about $10,000 to $12,000, depending on the class of machinery selected.

What is the average cost of producing ice?

Average cost of producing a ton of ice in a plant of this size would be governed a great deal on local conditions, and the price of fuel. But with coal at $3.00 per ton, and the plant operating at its full capacity, you should be able to produce a ton of ice for about $1.25.

What does it generally sell at, especially in the South?

Ice, delivered, retails at 35 cents to 50 cents per hundred lb., and by the ton in less than carload lots $4.50 to $5.00. In car loads $3.00 to $4.50 per ton.

W. H. Beisley.

Steam Engine and Pump Questions

WILL you kindly answer the following questions in the columns of Practical Enginer?

1. Why are engines without flywheels hard to reverse?

2. How high will a pump, with an 8-in. steam cylinder and a 6-in. water cylinder, raise water when the steam pressure is 80 lb.?

3. How can you ascertain whether or not a piston is leaking without removing the cylinder head?

4. How would you keep a Corliss engine in operation with valve stems broken?

5. If the shims should become mixed when filing the brasses of an engine how would you find out how to replace them?

6. How can you ascertain the length of the valve stem and rocker arm on a slide valve engine?

A. In reversing an engine that has no flywheel or other revolving element of a similar nature, there is nothing to create an inertia and as soon as steam is shut off, the engine will stop at once, and this usually takes place at the end of the stroke where the direction of the reciprocating parts is changed, thus leaving the engine "on the center," for this is where the friction of the moving parts is greatest.

Where an engine has a wheel or other revolving element, this will continue the motion for some time after steam has been shut off by reason of the inertia stored up in the wheel and when the wheel has almost ceased to revolve, the reverse lever can be thrown to the opposite position when the engine will tend to stop owing to the changed position of the valves imprisoning a certain amount of steam or air in the cylinder and this is compressed by the inertia stored up in the flywheel so that at the very moment that the moving parts come to rest, the reaction of this imprisoned air or steam in the cylinder immediately starts the rotation in the opposite direction unless it is released.

2. The area of an 8-in. piston is approximately 50 sq. in., and the area of a 6-in. piston is approximately 28 sq. in. Then 80 multiplied by 50 equals 4000, which is the total number of pounds pressure exerted on the steam piston. Then 4000 divided by 28 equals 143 lb., (nearly), which is the pressure on the water end that would just balance 80 lb. on the steam end.

Owing to friction of the moving parts, however, some allowance must be made in order that the resistance of the water end is less than the pressure at the steam end and enable the pump to run. Allowing 25 per cent for friction, this will leave 107.2 lb. as the greatest pressure that the pump will work against.

Then dividing 107.2 by .43 which is the pressure exerted by every foot of height, gives 249 ft., which is as high as a pump of this size will force water with 80 lb. initial steam pressure.

3. Place the engine on the center, or block the crosshead thoroughly and admit steam on one side of the piston. Open the indicator valve or cylinder cock at the opposite end, and if the piston leaks, it will show out of the opening.

4. On Corliss engines of recent design it is general practice to make the weakest part at the driving end so that if from any cause, a valve stem should break, there will be enough of the stem visible so that it can be secured and wedged if necessary.

Should an exhaust valve break, secure the stem in any convenient manner that is substantial, so that the valve will remain in an open position. Then adjust the steam valve at that end so that it will remain closed. This can be done in several ways, depending on the engine. If the speed of the engine is not too great, shortening the steam rod so that the crab will not engage is a good way and this can be done easily, while the engine is in operation.

Shortening the droprod is another good way. Some engines have an adjusting screw by which the amount of contact of the crab can be adjusted within a great range, even while the engine is in operation, and by adjusting this screw, the crab can be set out so far that it will not engage the drop lever, and the valve will thus remain closed.

Should the steam valve stem break, use any of the above methods described to close the steam valve, and keep it in a closed position. If possible disconnect the exhaust valve stem at that end so that the valve will remain in an open position. This is to prevent the creation of a partial vacuum effect in that end of the cylinder on the out stroke. However, as the above suggestions are for simple noncondensing Corliss engines, if the exhaust valve stem broke on a condensing engine it would be better to let the exhaust operate in the usual manner as even at that the retarding effect on the outgoing piston would be less with the valve operating in the usual manner, than if the valve were open and the piston exposed to the retarding effect of the condenser, which would be much greater. It would be a case of choosing the less of 2 evils.

5. We infer from your question that the engine is operated with the brasses on the crank and crosshead pins, brass-to-brass, and that the striking clearance in the cylinder is adjusted by means of shims on the brasses. Such being the case, it would be perhaps best to locate the striking points on the slide and transfer the both to one end, say the crank end, and then adjust the connecting rod by means of the assortment of shims until the main "witness mark," is half way between the "striking marks." This might require more than one attempt, but many times there are general features about misplaced articles like this that assist one to reason his way out of the difficulty.

Make it a point when taking down cranks or eccentrics wherein shims are used to secure adjustment, to mark all parts so that when assembling them again, that there will be no mistakes made in putting all parts back in the right place.

6. In order to find the length of a proposed valve stem for a slide valve engine, it is first necessary to know what the valve travel should be. Under ordinary conditions, the valve travel of a plain slide valve engine should be a distance equal to twice the width of the steam port plus twice the width of the lap, so that if the steam ports were each 1¼ in. wide and the valve had an inch lap, then the valve travel would be 4½ in., and the throw of the eccentric should be enough to give the valve this travel. If the throw of the eccentric is less than the valve travel, then a carrier arm proportioned so as to produce the necessary increase must be provided, and with this and the valve in the central position, the length of the valve stem is easily measured to meet the case in hand.

G. H. Wallace.

OIL FROM THE LARGE well recently drilled by the Myles Mineral Co. at Pine Prairie, La., is remarkable, according to an analysis made by the United States Geological Survey, in that it contains no asphalt, gasoline, or paraffin wax. The crude product contains a very large percentage of illuminating oil. In composition the oil stands about halfway between the oil of the Gulf field and that of the Caddo field.

The well has been connected with pipe lines and loading rack on the Rock Island Railroad, from which shipments are now being made. Eight other wells are in process of drilling.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Difficulty With a Boiler

FIGURES 1 and 2 show a boiler installation under my charge. The boiler room was built and afterward a boiler was made, under contract, that would fit it. It was guaranteed to develop 150 hp. and was

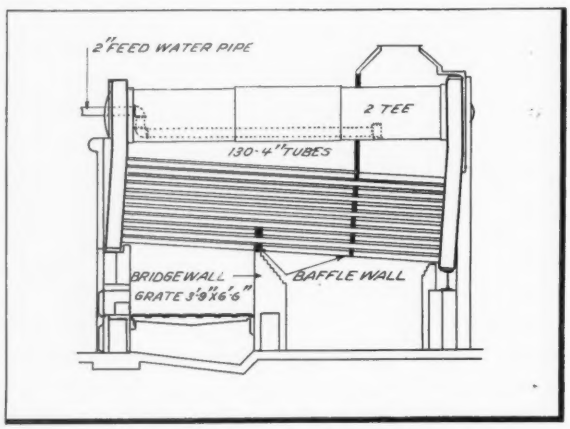


FIG. 1. BOILER AS FIRST ERECTED

provided with a 3 ft. 9 in. by 5 ft. 6 in. grate; 130 4 in. by 11 ft. water tubes; a 42-in. dome and 2 firing doors.

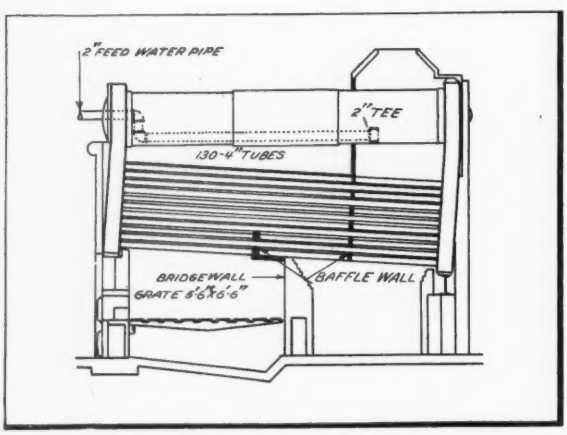


FIG. 2. BOILER AFTER CHANGES WERE MADE

This boiler and 2 boilers of a different type were connected to a 54 in. by 90 ft. stack, as shown in Fig. 1. The boiler was given a 24 hr. test by an expert but did not develop 150 hp. I never was told what it did develop, but figured it out myself at 146 hp. The water was weighed, also the coal and ash. The expert was furnished by the contractor.

When the boiler did not develop the required hp. the only remedy was to increase the grate surface. It was increased as shown in sketch, Fig. 2, without changing the baffle wall, and another test was made. It developed 150 hp. and was accepted. In a short time the front baffle, which was of no benefit after changing the grates, burnt out, and the heat went out direct, utilizing only a small part of the heating surface and causing such rapid circulation that the boiler primed when overcrowded. I would like to hear what some of the engineers think of it. F. J.

Bearing Phenomenon

I HAVE a 7½ by 4-in. white-metal bearing. In the summer time during hot weather the bearing runs hot and as the atmosphere cools the bearing cools. The speed of the shaft is 750 r.p.m. and is lubricated by 2 ring-oilers. There is a small thrust collar in the center of the shaft. Can any of the readers explain this phenomenon? H. P.

Heating System

LAST summer the plant where I am employed burned and we are now about to install a heating system in the new plant. The old heating system never gave satisfaction.

I have given the company my idea of a system that should work out better than the old one.

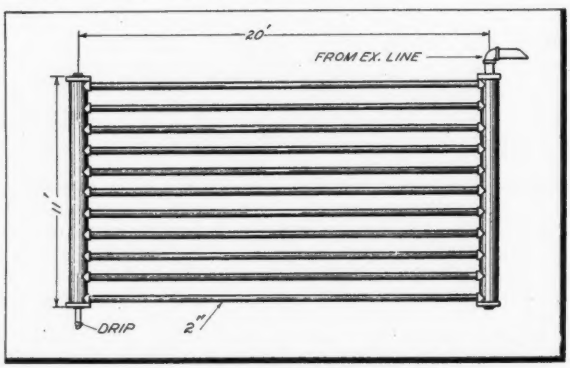


FIG. 1. ELEVATION OF RADIATOR

We use exhaust steam in the day time and live steam at night. My idea is to run a 6-in. line from the exhaust line of the engine long enough to connect with 8 radiators, 4 on each side of the line as shown in Fig. 2.

Radiators are 20 ft. long, 11 ft. wide and there are 11 2-in. pipes in each. Each radiator is to be connected to the 6-in. line by a 3-in. pipe. We intend to use a 1¼-in. drip pipe with regulating valve. We also intend to use a syphon system in the exhaust line close to the engine.

Will connect a tee to the exhaust line from the engine and to this attach the 6-in. line connecting with the radiators. A bushing for a ½-in. pipe will be placed in the end of the tee, the ½-in. pipe to

extend about 2 ft. into the 6-in. pipe and will have the opening in the end reduced to ¼ in. as shown in Fig. 3. After starting the engine live steam will be turned into the ¼-in. pipe and it will syphon exhaust steam from the exhaust line of the engine.

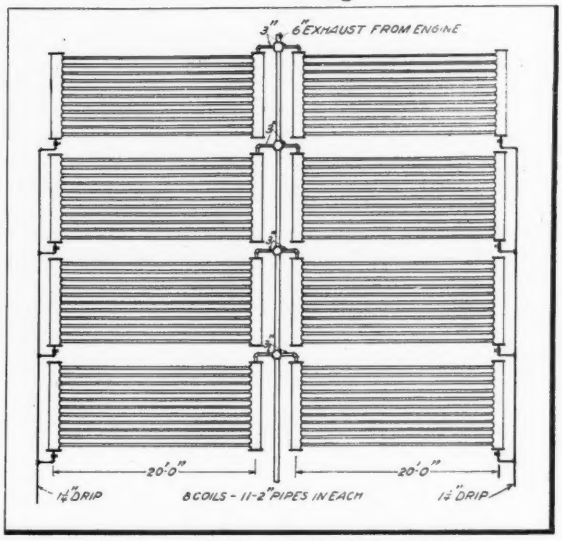


FIG. 2. LAYOUT OF PROPOSED SYSTEM

I have also suggested another plan which substitutes 2 4-in. pipe lines connecting 4 radiators each, instead of one 6-in. line. Exhaust line from engine to feed-water heater is 7 in. The exhaust line from the heater is about 10 ft. 8 in. long.

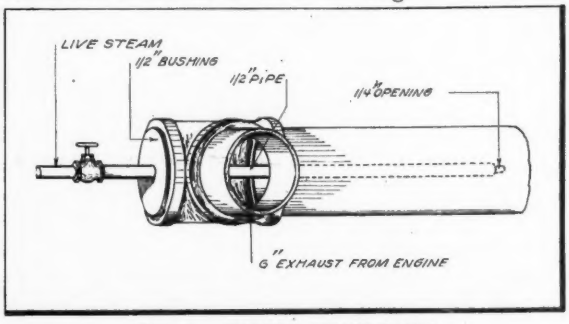


FIG. 3. SYPHON CONNECTION

I propose to put an 8-in. tee in the latter line and connect the 2 4-in. lines for the radiator supply. A 4-in. pipe with a relief valve for regulating the back pressure on the engine is also connected to the heater.

Will some of the readers of Practical Engineer give me their opinion as to which is the best system to install? P. C.

Indicator Connections

IN a recent issue, J. W. Dickson shows some unusual indicator cards and asks for an explanation of their peculiar appearance relative to the change of indicator connections.

In the first place, insufficient data accompanies the cards to enable one to determine accurately certain points necessary to make deductions which are practically correct.

The atmospheric line is omitted from 3 of the cards therefore, locating the theoretical expansion line would be only approximate. The boiler pressure is not given, consequently we are unable to determine the drop between the boiler and engine, also what effect the spring may have upon the outline of the card.

The admission line on the 3 cards taken with the side pipe and 3- way cock look rather too straight to be accurate, however, a slight leak, either in the exhaust valves or piston, may be the cause of this. As the leak does not show up on card No. 1, I am inclined to believe the leak is in either the 3-way cock or the indicator piping. If there are no leaks at these points, it is possible that the pencil comes in contact with the paper clip before the piston has completed its stroke, consequently the apparent leak and the very straight admission line.

The falling away of the steam line on card No. 1 might indicate restricted ports, but the same defect is not seen in Nos. 2 and 3, where it should be more pronounced if the above was the cause, for it would be aggravated by the use of the 3-way cock and the side pipes. We find the same falling away of the steam line on card 4 also.

The exhaust valves do not open soon enough, or the exhaust ports or exhaust pipe is restricted, for the counter pressure line does not show its lowest point until well toward the center of the stroke.

I believe the pecularities of cards 2, 3 and 4 when compared with No. 1, are principally due to a faulty indicator outfit and the method of manipulation. The fact that all of the cards are not of the same length, the apparent leaks on cards 2, 3 and 4, while none shows on No. 1 and the bumpy steam line on the right hand end of No. 4, bear me out in this statement.

Of course, I note that he writes: "Cards taken with the same indicator on another engine under similar conditions were normal." This may be correct but, did the same person take the cards from the other engine? Then too, a reproduced set of those cards would have been of interest and may have given us some comparisons which would have lead to the detection of the cause for the phenomena.

The card marked "piston leakage" is somewhat of a puzzle to the writer. At the release end where it is marked leakage the appearance is very much as though the expansion was below the atmosphere and there being another engine or pump exhausting into the same line as the engine from which this card was taken, when the exhaust valve opened the pencil was pushed up above the counter pressure line due to a kick from the other exhaust, after which it dropped back to the normal back pressure line. The other 3 points, "High clearance, dead motion and hard spring" are new ones to many of us and an explanation would be appreciated. A. K. Vradenburgh.

How Many Gages of Water?

I SHOULD like to hear the opinion of brother engineers as to how many gages of water to use in a return tubular boiler. I have my own opinion, but have been told that I was wrong. J. R.

Problems

WHAT will be the effect of mounting a safety valve on a pipe at some distance above the nozzle on the boiler? Can any readers give the results of such mounting from experience?

We have a big injector which is capable of feeding several of our boilers but have not been able to make this work satisfactorily on a common feed pipe. What is the proper method for installing an injector to feed 2 or more boilers at the same time? C. A. M.

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THOSE LETTERS

Directions for overcoming troubles from the man who did the work, the opinions of practical men in regard to operating power plant machinery, explanations of the causes of troubles encountered in the plant, emergency remedies, are among many of the things that can be obtained by reading the letters direct from the plant published in each issue.

One of the most perplexing problems that an engineer has to meet is water hammering. The most carefully designed and constructed system of steam piping sometimes gives the most trouble. Slight settling of a main header, a branch line out of use where steam may condense, and numerous other causes of water hammer may be cited. The results range all the way from a disagreeable noise to a broken fitting, causing a shut down or more serious damage to the plant and its operators.

Problems of this nature require individual solutions and we have 2 excellent examples in the letters from W. J. Maxwell and I. M. Coming.

In the operation of a power plant one of the bugbears of the fireman is oil in the boiler. We are frequently told of the dangers likely to come from this condition but when we read Mr. Debo's letter it gives us an uncanny feeling until we are certain no oil gets into our boilers.

Expansion of steam piping is another of those questions which is always causing trouble in a plant, it must be provided for or serious failure is inevitable. Blowoff piping is not immune from this trouble though it is usually short and direct and does not require the care needed in laying out steam piping. Attention is called to these troubles by Mr. Hartley who gives a particular case and how it was remedied.

There are other letters in this issue just as important as those mentioned above and to serve best the purposes of the engineer they should be kept in such shape that quick and ready access can be had to them by any man about the plant. There are 2 systems which might be suggested. The first, and perhaps most common, is to clip from the magazine all those letters which contain information in regard to apparatus with which you have to work, and preserve these clippings in classified note books or scrap books.

The second system is to preserve the complete magazine and make an index, a card index is most convenient, by means of which one can be directed to an article treating the exact subject upon which information is desired.

Collection of information on the operation of a power plant should not stop with the magazine; points gained through personal experience should be written in full and classified along with the other articles. To get these notes into a permanent form and at the same time give other engineers some benefit of your experience it would be well to submit them to Practical Engineer for publication. It is quite likely that your letter will suggest to someone else another way to overcome the same difficulty and in this way a variety of methods may be explained and classified.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Spring Meeting at Cleveland, O., Reports of Papers and Discussions

PAST PRESIDENTS HAD BEEN particularly urged to attend this meeting, and at the opening session on Tuesday there were present many whose names are familiar throughout the mechanical world. Ambrose Swasey, famous builder of big telescopes; Robert W. Hunt, whose designs and tests have shaped much of our structural practice; Jesse M. Smith, a foremost expert on patent causes; E. D. Meier, head of the Heine Boiler Co.; Geo. Westinghouse, founder of the Westinghouse Companies; S. T. Wellman, first maker of open hearth steel furnaces in this country, and A. C. Humphreys, president of Stevens Institute and a pioneer in modern methods of gas manufacture. Others who could not be present, but who sent greetings, were: John E. Sweet, inventor of the Straight Line engine; John Fritz, whose genius devised the present form of rolling mill; E. D. Leavitt, engineer of the Calumet and Hecla Mines; H. R. Towne, president of the Yale & Towne Mfg. Co.; J. M. Dodge, constructor of Dodge cold storage plants; M. L. Holman, J. R. Freeman and F. R. Hutton.

The session was opened by Mr. Swasey and Mayor Baker spoke happily of the great advance in recent years of the professions, instancing surgery in medicine and transportation in engineering as examples. He questioned whether the benefits derived from such progress have been as widely distributed as they should be, and whether, unless the benefit to the race is not widespread, rather than confined to a few, and adequate, we shall not develop an unstable form of civilization. He welcomed the Society to Cleveland and hoped for a pleasant stay.

In replying, President Humphreys agreed that the engineering profession has a responsibility for spreading the benefits of progress, but was of the opinion that the slowness of that spread and concentration of the returns from mechanical progress has been due to lack of consultation of law-makers with the engineers in framing legislation.

Amendments to By-Laws

SECRETARY C. W. RICE then announced the election of new members, and the passage of an amendment empowering the Council to pay expenses of annual semi-annual and monthly meetings, and of such branch meetings as it saw fit from time to time, such payments to be governed by rules adopted by the Council.

Report of the special committee on by-laws was read by Jesse M. Smith, chairman, and recommended: 1st, election of members by sealed letter ballot of the Council instead of the membership as heretofore, one negative vote to defeat for honorary membership and 2 for other grades; 2nd, creation of a new grade of membership, intermediate between Junior and Member, to be called Associate Member, age to be 25 yr. or over, and applicant to be an engineer or teacher of engineering of established ability; initiation fee and dues to be the same as for a Member; 3rd, that the committee on constitution and by-laws be made a standing committee instead of special.

Some criticism was made of the name of the new grade is likely to be confused with that of Associate which now exists and would be continued, but no change was made. The amendments will, therefore, come up for action at the fall meeting.

Cylinder Analysis

TAKING up professional papers, Mr. Clayton gave an outline of his work on Diagram Analysis, which was presented in May 15 and June 1 issues of Practical Engineer.

Discussing this, Arthur L. Rice told of using this method with good success in practical work, and commented on the assistance which it will give in keeping track of the operation of a reciprocating engine. To make the method universal, it is necessary to determine values of the slope n of the expansion line for various types of engine at various pressures, as the values found by Mr. Clayton apply only to Corliss simple engines without steam jackets.

Professor F. E. Cardullo called attention to a meth-

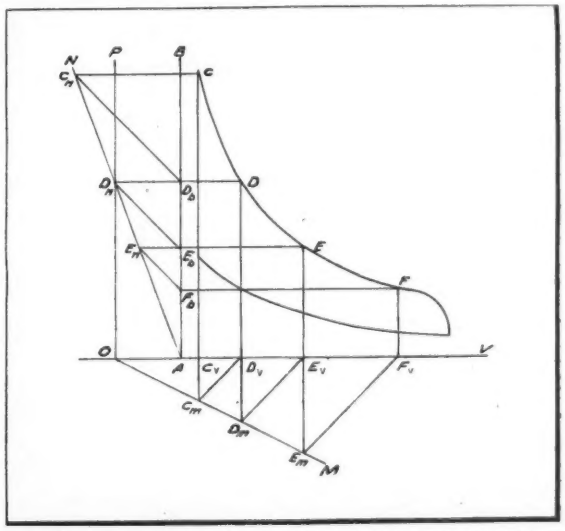


FIG. 1. DETERMINING CLEARANCE FROM THE DIAGRAM

od of determining clearance that is quicker and more accurate than the Clayton method, and is based on the expansion curve being a hyperbola. Referring to Fig. 1, CF is the expansion line of a diagram from a gas engine; OV is the line of zero pressure. At any point on OV, draw a perpendicular AB and a line AN at any convenient angle. Draw CCn, and from Cn draw CnDb at 45 deg. to AB. Draw DbDDn and DnEb at 45 deg. to AB. Draw EEn and EnFb. Draw FbF.

Now draw FFv perpendicular to OV and from Fv draw a line at 45 deg. to AB. Drop a perpendicular from E to Em and draw a line from Ev at 45 deg. Drop a perpendicular from D to Dm and draw from Dv to 45 deg. Drop CCm perpendicular.

CmDm and Em should be in a straight line if the expansion curve is a hyperbola and the work has been correctly done. Through these 3 points draw a line, and at O, where it crosses OV, erect a perpendicular to OV. This will be the axis of zero volume, and its distance from the admission line of the diagram represents the amount of the clearance.

Professor Cardullo raised questions as to the effect of variation of the cylinder with temperature with variable load; the effect of leaky valves on quality of steam; whether steam as measured in high and low pressure cylinders of an engine agreed or not. He suggested that the steam meter may be more accurate for measuring the steam used than analysis by the Clayton method; did not think that amount of leakage could be accurately determined from the logarithmic diagram; and suggested the possibility of an indicator which would draw the logarithmic diagram direct.

R. C. Stevens, of the Skinner Engine Co., called attention to the lack of data on single valve engines of slide or piston valve type in Mr. Clayton's work and called attention to the fact that steam which leaks directly by the valve from steam space to exhaust space without entering the cylinder is not shown by the diagram analysis. He stated that from tests, this leakage may be as much as 22 per cent, tests at the University of Pennsylvania having shown increase of steam consumption from 26 lb. to 32 lb. per hp.-hr. for a piston valve 0.01 in. under size, a leak of 23 per cent. Also test on one 80-hp. engine showed leakage of 624 lb. of steam an hour in this way, corresponding to 21 hp. lost, or 25 per cent leakage.

Mr. Moss agreed that this valve leakage must be considered carefully, as it is an important factor in steam engine losses.

Other papers of the session were a description of the Machinery in a Modern Flour Mill, given with lantern slides by J. F. Harrison, and the California Gold Dredge, read by title. Neither of these received any discussion.

Gas Power Section

AT the same time, the section devoted to gas power was considering papers on Natural Gas Engineering, by T. R. Weymouth; on Tests of Carbureters, by G. W. Munro; and on Bituminous Coal Producers, by C. M. Sarland.

Mr. Weymouth gave the analysis, heat value and specific gravity of gas from all productive areas of the United States and showed that the heating value is directly related to the specific gravity, the relation being shown by the equation:

B.t.u. per cu. ft. at 60 deg. F and 14.65 lb. = 1440 × specific gravity + 6.6,

this being close enough for approximate work. For accurate work his table should be used.

Equations and curves were also given showing the friction in pipe lines, the power required to compress gas and a method of designing a pipe line of given capacity, best number of pumping stations to use, best pressures to adopt, and size of compressors required.

In presenting the results of some 400 tests on carbureters, Mr. Munro outlined the difficulty of separating engine and carbureter performance, since a carbureter must always work with an engine. As the matter of efficiency in use of fuel becomes of consequence in automobile work, it is, however, important to know the effect of carbureter action on fuel economy, and Mr. Munro has suggested as a possible basis of comparison the best performance that can be secured from a given engine when tested with a number of different carbureters.

Six carbureters were tested at engine speeds of 300 to 1200 r.p.m. and with 10, 20, 30, etc., lb. on the brake arm up to the maximum load that the engine could carry. The engine was a 4-cylinder, 4-cycle automobile type with 4½ by 5 in. cylinders, 1 spark plug to each cylinder and timer that showed the ignition point in degrees of crank position from inner dead center. Prony-brake load was used, well oiled and steady. Gasoline had a specific gravity of 0.723 and was supplied from a vertical calibrated tank with gage glass. Best conditions of spark setting were found by trial for each test, the engine being adjusted for maximum load at 1200 r.p.m., to run light at 300 r.p.m., to speed up properly under throttle control and to work between the above limits under spark and throttle control without misfiring, backfiring or smoky exhaust. Each test lasted 6 min., readings being taken at 1-min. intervals.

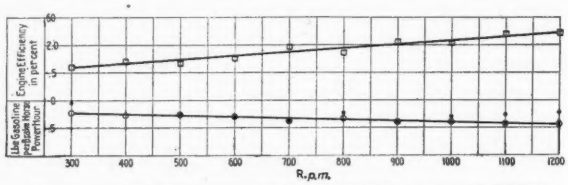


FIG. 2. BEST PERFORMANCE OF ENGINE AT EACH SPEED

The curves of best performance show a decrease in gasoline used per brake horsepower-hour as speed increases, Fig. 2, being 0.8 lb. at 300 r.p.m. and 0.6 at 1200 r.p.m.

Economy also was better as load became larger, Fig. 3 being for 800 r.p.m., 1 lb. gasoline per horsepower-hour at 20 lb. on the brake beam and 0.65 lb. at 73 lb. on the brake.

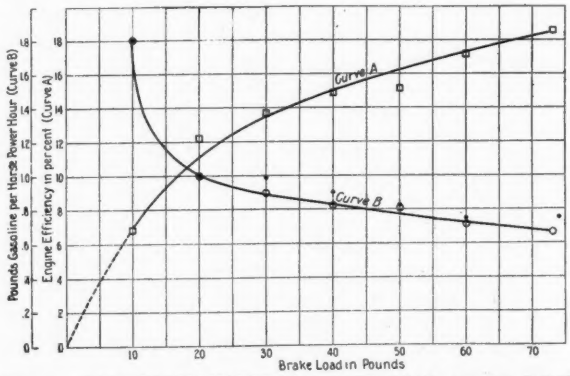


FIG. 3. BEST PERFORMANCE FOR EACH LOAD AT 800 R.P.M.

The paper on bituminous coal gas producers contained much data from performance of plants using coals from Pocahontas to Lignite and gave valuable cost data which will appear in a future issue.

Afternoon excursions to manufacturing plants and points of civic interest occupied those in attendance until evening, when an interesting lecture on sound waves and demonstration of their form by means of a new device, the Phonodike, given by Prof. Daton C. Miller, of Case School of Applied Science, claimed the interested attention of all.

THE WATSON-STILLMAN COMPANY, 50 Church street, New York, announces the following officers as chosen at a directors' meeting May 15th: President, E. A. Stillman; vice-president and secretary, A. F. Stillman, treasurer, J. P. Bird; chief engineer, Carl Wigtel; superintendent, Frank Lary. A new branch office is to be opened at Philadephia shortly and shop facilities are being improved to meet increasing business.

POSITIVE FACTS can be told in a plain way and the science of engineering is built upon facts.

MEETING OF THE ILLINOIS STATE ASSOCIATION OF STATIONARY ENGINEERS

At Decatur and Urbana, Ill., May 23 to 25

A LARGE exhibit, fine weather and good attendance were the special features of the Illinois State Convention of 1912. Including the trip to the State University at Urbana, and the papers presented before the delegates at the convention in Decatur, it may well be ranked as the best educational convention that has been held in the state. And the fact that an engineers' license law was adopted as of satisfactory form for presentation to the legislature marks also another step in advance.

All sessions of the convention, except those held in Urbana, and the exhibit of engineering supplies were held in the Millikin-McRoberts Building on North Franklin St., in Decatur. The opening session was on Thursday morning, Mr. Wortman, president of the local organization calling the meeting to order. After the invocation by Rev. W. H. Penhallegon, Mayor Dinneen gave an address of welcome which was responded to by National Secretary Fred Raven. Further addresses were made by Judge O. W. Smith, responded to by National Vice President, John McGrath, by John F. Alt, president of the state association, by John W. Lane, on the purposes of the organization. Afterwards adjournment was taken, and the afternoon spent in visiting plants about the city.

In the evening, a paper written by A. W. Cash on Steam Reducing Problems, was read in his absence by another member, and the points of whether or not reducing valves could cause superheat beyond in the pipes was vigorously discussed.

Illinois License Law

FREED from technicalities and legal form the provisions of the proposed bill are as follows: The state will be divided into not less than 8 districts, having a district examiner in each. These districts are to be appointed by the chief examiner from an eligible list supplied by the state civil service commission. The chief examiner, who is to be appointed by the Governor with advice and consent of the state civil service commission, must be a practical steam engineer with not less than 10 yr. experience prior to his appointment. Each district examiner must have 7 yr. experience. The chief examiner is to give bonds for the faithful discharge of his duties for the sum of $3000 and each district examiner for the sum of $2000. The chief examiner is to have office in the state building where the record of his department will be kept and there will be appointed clerks sufficient in number to keep these records. These clerks are to be appointed from an eligible list supplied by the civil service commission and to give bonds for $1500 for the faithful discharge of their duty. All appointees are to give their entire time to the work of the office. The salary of the chief examiner is to be $2400 per year and of the district examiners $1500 each. Traveling expenses actually incurred in the discharge of duties are to be allowed and paid upon the warrant of the state auditor.

All persons operating a stationary steam boiler carrying more than 15 lb. or any boiler or steam apparatus of more than 15 hp. must obtain license to do so and no owner of steam boiler or steam apparatus shall permit it to be used except when directly in charge of a duly licensed engineer.

All persons desiring to obtain license must pass an examination on steam boilers and steam apparatus according to rules laid down by the state examiner, examination to be of a practical nature and uniform throughout the state. If the applicant should be found proficient, license will be given him to act one year from date, but the license may be revoked one year from hearing upon written charges of fraud in obtaining license or of insanity, or of being addicted to use of liquor or drugs in excess so as to render him unfit for duty, or for gross neglect. The holder shall be entitled to renewal annually except the holder shall be refused as in the cases mentioned above. The fee is $2.00 per annum. All fees to be received by the district examiners to be remitted to the chief examiner on or before the 5th day of each month. Any engineer who makes an affidavit that he has had 3 or 4 yr. experience as a steam engineer just preceding his application and shall have a certificate of the fact from his employer, shall be granted a license for the plant he is operating without further examination, and any person holding a license granted by the Board shall, upon showing the license and paying the fee, be granted license without further examination. Any person dissatisfied with the action of district examiner in refusing a license, revoking it, or refusing renewal may appeal to the chief examiner, who shall investigate the matter and shall sustain the district examiner or require him to issue license to the appellant according as he finds the justice of the case. Every engineer must exhibit his license under glass in a conspicuous place in the engine room and upon neglect of same shall be fined not to exceed $5.00. Any engineer, or owner, or user of steam apparatus violating the conditions of the law except the violation in not displaying a license, shall be fined not less than $10.00 or more than $100.00. The law shall not apply to steam apparatus or steam boilers under jurisdiction of the United States or to locomotive boilers or engines. The law is not to apply to traction engines or to the use of traction or stationary engines on farms for purely agricultural purposes.

The chief examiner is to pay all money received by him from district examiners into the state funds on or before the 10th day of each month, and give an account to the governor of all money received by him and paid into the state treasury.

The Trip to Urbana

PROMPTLY at 8:30 Friday morning, 2 big interurban cars of the Illinois Traction System departed from the headquarters of the convention at the St. Nicholas Hotel, and were on their way to the seat of the State University at Urbana. A quick run was made without incident, except the usual jollity which prevails on such an excursion, and the delegates were met at the campus by Prof. C. R. Richards of the department of mechanical engineering, and by him and other guides were escorted first to the steps of the Auditorium Building on the south campus where a group photograph was taken of the delegates and supplymen in attendance.

As soon as the rather complicated job of getting all these restless and energetic individuals recorded on a photographic film was completed, the assemblage

went to the lecture room in the Chemical Building where they were greeted by Doctor W. F. M. Goss, dean of the school of engineering. Dean Goss spoke as representing both the faculty of the school of engineering and also President James of the University, who was unavoidably absent in Chicago. He welcomed the delegates as the University always welcomes guests and stated that it was a natural thing for the steam engineers of Illinois to come to the State University to see what was being done there in the teaching of engineering and the investigation of engineering problems.

He gave some data in regard to the University, which now has 4000 to 5000 students, 1200 of these being in the engineering college, which has 100 instructors. The work of the department is the outcome of 50 yr. growth, a large part of the increase being accomplished in the last 10 yr. The ideal of the school is now to furnish a course in engineering and any information asked for by industries of the state on any subject. Not only is an engineering college maintained, but also an experiment station and research laboratory for the investigation of industrial problems pertaining to any industry; conferences are frequently held between owners of plants and the representatives of the engineering department on the problems which will be of value to have solved, and these problems are taken up in the experiment station.

Doctor Goss suggested that the visit of the engineers to the University should partake of the nature of a conference between the owners of the University and the force who are trying to operate it, stating that the University is owned by all the citizens of the State and that the teaching force welcomed suggestions and criticisms.

Replying to this, John W. Lane stated that while they appreciated the advantages of the State University and what it was doing, he believed that its work could be broadened, that criticisms were in order and that the University might well undertake something which would fill in the gaps between the somewhat irregular development of the practical man and the well rounded development of the man who has taken a full engineering course. He suggested that it should be in order for every engineer to send questions to the University for answers and that it would be helpful to both University and engineers if every year a 2-days' meeting could be held at the University at which the engineers would be given a resume of the progress of the past year and a demonstration of the work that the different departments are doing.

He suggested also that the help of the engineers would be of assistance if they were well informed as to the work of the University in getting the needed funds from the legislature to carry on the University work. He spoke of the past dispairing prejudice against the college bred engineer and stated that if the practical man of future loses his job to the college man it is his own fault, because the engineer of the future must study the operation of the plant for profit and must put himself in the position of manufacturing and selling power to the owner of an industrial establishment. Their brains must be used in operating even the best installation that ever was devised in order to get good results, and that the requirements of the future will call for a broad gaged man who knows how to operate each part of the plant successfully and at a profit. He was glad that the ice had been broken by this visit to the State University and hoped that the relation would continually grow closer between the University teaching force and the practical men of the State.

ENGINEERS AND FRIENDS IN ATTENDANCE

Following these addresses, Prof. S. W. Parr told something of the experiments which have been carried on at the University in regard to the storage of coal, the starting of fires by spontaneous combustion and the loss by storing in the open air, and other experiments of interest to the power plant engineer. He then spoke at some length on the matter of specifications for the buying of coal, stating that he believed the purpose of the specification should be to let the buyer pay for what he gets and to cause the seller to deliver that which he is paid for.

He called attention to the difference between the present conditions and those in the days when only eastern coals were used. The eastern coals were fairly

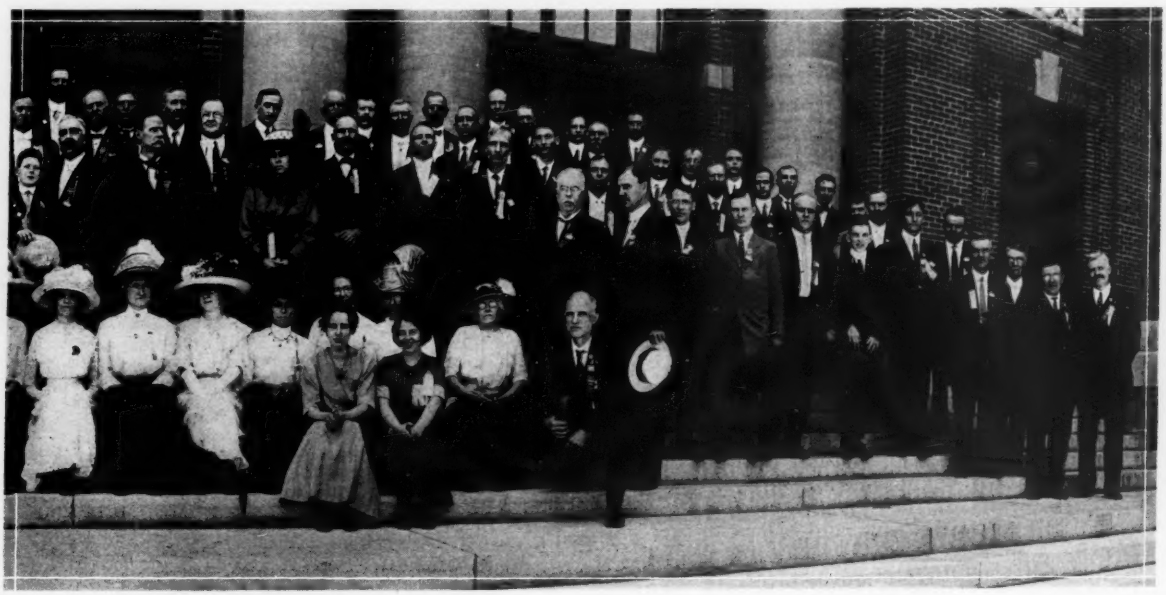
uniform, containing about 6 per cent ash, 2 per cent moisture and 2 per cent of a non-combustible or a total of 10 per cent material which could not be burned. These coals ran with a heat value of about 14,000 B.t.u. per pound and were much alike, so it was a case of coal is coal. Comparing this with coal as furnished recently to the University of Illinois in which ash is 20 per cent, moisture 12 per cent, and other noncombustible 13 per cent or a total nonburnable material material of 45 per cent, having 9000 B.t.u. per pound of coal, it will be seen it makes some difference to have some means of checking up.

Prof. Parr believes that investigations as used in the past have usually been too elaborate and required too much calculation. He states they should be simple. He believes the user must know the quality of fuel by studying the mine and the method of mining of the coal, and believes that the cost per 1,000,000 B.t.u. is the basis on which comparison of coals should be made. He does not believe that the ash when above the specified value should be penalized because he thought that this penalty had already been imposed when the reduction in pay for lower heat value was exacted. He stated that the heat analyses of many samples of coal and from many sections had shown that for any given mine, and almost for any given district or country the heat value of the coal will be as constant as the determination of the heat units would be, that is, the variation in the heat value will not that the reduction on payment is not a penalty for high ash, but is simply a just payment of damages for reduction in the efficiency of the boiler, due to the higher ash and for the greater cost of handling both ash and coal. Prof. Parr consented that this might be true.

Following this address, Prof. Edward Bartow told of the work of the State Water Survey, stating that 4 men are now giving their time to this work, 50 per cent of this time being spent in the field on tests of water supplies and going over water sheds to make sure that there is no contamination of the water supply and to look for opportunities of helping procure good water for municipalities, and industries. The department is now in shape to make free tests of any water which may be sent to it and to assist in obtaining a supply of good water for domestic or manufacturing purposes including boiler feed water supply.

These tests determine the mineral contents of all supplies in the State, and the amount of chemicals needed to soften the water, the tests being for soda ash and lime used outside the boiler. A pamphlet entitled "The Hardness of Illinois Municipal Water Supplies" has been issued by the University and is available to those who desire it. The paper gives the hardness of the water, the amount of lime and soda ash required to soften the water and the cost of the chemical per thousand gallons.

Prof. Bartow stated that it was found that the treated city water was better even than cistern water



AT THE ILLINOIS STATE CONVENTION

be greater than the possible errors of making the test. He stated that for coal furnished to the University of Illinois for 3 yr. there was a variation of not over 100 in 10,000 B.t.u.

The variables in the different coals are the ash and the moisture, and many big contracts are now let on specifications which call for a given mine and district. The ash and moisture are an index of the value of the coal, and by keeping track of whether there is about the same amount of ash from the coal as it is delivered, it is easy to tell whether it is coming of practically the same heat value.

Mr. Misostow questioned Prof. Parr as the matter of reducing pavement when the ash is high; he believed for domestic and industrial use. For the treating of well water a single analysis is sufficient as well waters are nearly constant in value, but where the supply is from a river or a pond, a constant and almost continuous analysis is necessary as the composition of the water is continually changing. He cited the cases of Winnipeg, where the saving was $38 per million gallons to those using the water, and in Oberlin, Ohio, where the saving was $12 per million gallons, the cost being very much less than this in both cases. He also spoke of the saving in repairs of boilers by having the water softened, giving as an instance the locomotives of the C. B. & Q. Railroad, where 40 per cent of the cost of repairs was saved by softening.

He showed that by decreasing the mineral contents 10 grains per gallon, the life of the boilers would be increased 100 per cent, and by decreasing 20 grains per gallon 200 per cent, the cost of chemicals and plant for such reduction being but small.

Following this address the delegates were taken to the restaurant of the Y. M. C. A. Building where luncheon was served, and after luncheon they assembled in the lecture room of the engineering building where they were addressed by Mr. Clayton who gave in substance the method of diagram analysis, published in the May 15 and June 1 issues of Practical Engineer.

Following this, Prof. Luitweiler told of the work in machine design done during the junior year and the work in power plant during the senior year of the engineering courses. For the present year the junior engineers are engaged in the design of a punching machine, starting from the requirement to punch a given size hole in a given thickness of plate and going from that to the power required, the strength of the parts and so on, making a complete design in all details.

Power plant design comes in the second half of the senior year and is started with the actual load curve from some station, going to the decision on the number and type of units to be used and the capacity of each, then from the water rate curves, starting on the size boiler and pumps, the size motors to drive the pumps, whether the pumps will be driven by steam turbine or reciprocating engine or motor, then to the size of the air pump required which is usually taken as empirical from past experience of power plant practice; then to the condenser where commercial sizes are used, then to the hot well pump, the feed pump, tne feed-water heater, the design of the boiler as to heating surface, grate surface, volume of steam and of water; then the draft required to burn the coal needed, and the height and diameter of chimney, and then a program of operation of the plant is arranged for the 24 hr., stating what units should be on at each period, and from the efficiency curves of such units the coal required per day. From this data the size bunkers required, the capacity of the conveyors and the power required to drive them are laid out and the complete layout plans and sections of machinery and piping is arranged.

Following this address the delegates visited the drawing room where these designs were in progress, and then scattered to the different laboratories of the university including the power plant proper, the mechanical and civil engineering laboratories, the electrical engineering, the testing of materials, the shops for iron and wood working, and then to other parts of the university as individual delegates desired. At 5 o'clock all took the interurban car for return to Decatur and after dinner, the evening was spent in examining the exhibits and talking over the apparatus on display.

Saturday morning the delegates were called to order and the first business taken up was the selection of a meeting place for the coming year. On ballot Rockford, Ill., was chosen by substantial majority. Resolutions were then presented by Secretary Raven conveying the thanks of the delegates to the officials of the city, to the different companies who had contributed toward the entertainment of delegates, to the members of the local association, and the citizens and speakers, to the University of Illinois and the faculty for attentions shown on the visit, to the Central States Exhibitors Association for their entertainment and to others who contributed to the convention.

Unfortunately vice-president J. C. Moore was prevented from attending the convention by injury which made him a temporary cripple and in accordance with a general ruling of the national president in such cases it was impossible to promote him as has been the custom to the presidency. Under these circumstances John Morgan of Waukegan No. 3 was elected as president, Geo. W. Hollinger of Decatur No. 16 as vice-president, W. E. Hill of Moline re-elected as secretary-treasurer.

The officers were then installed by national secretary F. W. Raven, and following this came an address on "What I Know About Engineering," by ex-mayor J. F. Farrell of Ottawa, a paper on "The Higher Education for Engineers," by Prof. E. C. Woodruff of James Millikin University, and one by Prof. C. R. Richards on "The Transmission of Power by Gas."

Delegates registered were President John F. Alt, Ottawa, Secretary-Treasurer W. E. Hill, Moline, National Vice-President John F. McGrath, Chicago, National Secretary F. W. Raven, Chicago, Jacob Reitz, Theodore Sieben, Henry Pruhnke, P. H. Mahon, J. G. Beckerleg, G. F. Morang, H. Misostow, of Chicago; W. L. Parker of Elgin; G. M. Gould, B. F. Stokes, of Moline; J. F. Weingarten and J. Burghart of Rockford; W. C. Urban of Granite City; Albert Hickman of Peru; Henry J. Halm of Ottawa; John Hinkleman of Bloomington; Fred G. Weller of Peoria; John Morgan, David Wilson of Waukegan, and G. Hellinger and E. B. Chapman of Decature.

The Exhibits

"Everything for an Electrical Installation" was the substance of the legend which called attention to the exhibit of W. H. Jennings, of Decatur. Included were all sorts of electrical specialties such as Packard Mazda lamps, H. T. Paiste & Co.'s outlets and junction boxes, Paranite duplex wire, Bryant fuse blocks and switches, General Electric panel boards and cut-out boxes and other similar material.

Squires' automobile was not present but C. E. Squires & Co. had a space in which their steam specialties were advertised.

With ferns and spirea as a background, Crandall Packing Co. showed samples of its large and complete line of packings including the lip packing for hydraulic work, round, square, flax and diagonal packings for all uses, cut and molded gaskets, pump valves and sheet packings. F. M. Wheeler was in charge of the exhibit.

Pyramids of No-Cut valves showing all sizes and types, complete and sectioned, to illustrate the action of the protected seat which avoids cutting and wear, were prominent in the display of the Osborne Valve & Joint Co., of Chicago. Two large sectional photographs illustrated the fact that the area under the valve seat when the protecting extension is in action is greater than the area past the extension, so that the seat and the valve are not cut by the current of steam or water. Besides these valves the high-pressure joint as made between the ends of the pipe itself was illustrated. W. L. Osborne, secretary of the Central States Exhibitors Association, was in charge.

Bob Hills was, as usual, in charge of the exhibit of the Hills-McCanna Co. There were force feed pumps in round and square type, made with 1, 2 and 3 feeds, all fully nickel plated and shown both in complete form and cut through in section to show the action of the pistons and valves. A notable feature was the manifold feed having 16 outlets. Other features shown were the high-pressure gage cock, the combination low water alarm and fusible plug.

American steam gages and the American Thompson Improved Indicator with outside spring were most in evidence at the booth of the American Steam Gauge & Valve Mfg. Co., which was in charge of Chas. C. Kilander. The indicator was one containing all the well known special features of the American Thompson Improved and was shown with the special reducing motion which is provided with it. The gages were a 300-lb. recording gage, duplex gage, Ellison's differential draft gage with glass cover, the dead weight gage tester, the American H_2O grease extractor and feed water filter, marine speedometer, American inspector's outfit, American special pop safety valve and examples of the American planimeter and reducing wheel.

Dearborn treatment of visitors to the booth of the Dearborn Drug & Chemical Co. was as effective as its treatment

of boiler feed water. In charge of Messrs. O. E. Poole, J. G. Beckerleg, Fred C. Hickey and H. E. Hamsher, the space of this company was a center of attraction from which all turned away with satisfaction either because of the courteous explanation of how Dearborn treatment cures or with proofs of the company's generosity. Two booklet's, "Lubrication vs. Friction" and "Treatment of Boiler Feed Waters," were specially interesting.

F. E. RANSLEY, of Greene, Tweed & Co., president of the Central States Exhibitors Association, was busy with the arrangements for the exhibit as well as in attending to the display of the Palmetto packings in various forms, round, square and twist, and showing its self-lubricating qualities.

WHITE STAR VALVES and Union Disc valves are the 2 types particularly emphasized by The Wm. Powell Co., of Cincinnati. Both these brands are made in all sizes and in all types of gate, globe, angle, check and cross valves. Both have the safety grip wheel which insures a strong hold in opening or closing. Other features of the exhibit, which was in charge of Chas. Cullen and M. F. Brenner, were the Trojan lubricator for feeding cylinder oil and the Powell grease cups and oilers.

PEERLESS MFG. CO.'S GOODS in all lines were shown by Geo. B. Carpenter & Co., of Chicago, who are General Western Agents for the Peerless Mfg. Co. C. A. Elliott acted as representative and displayed Perfected Hose, Rainbow belting, Rainbow packing, Eclipse gaskets, Peerless special canvas hydraulic packing and spiral packings for pumps and valve stems.

FROM THE CHICAGO OFFICE of V. D. Anderson & Co., C. H. Fisk was present showing sections of the Model D trap with the new and improved valve and relief and of the Anderson oil filter in which the oil is all passed through filter paper, thus giving perfect removal of all impurities. The Anderson data book was the perquisite of those who visited the booth.

JENKINS VALVES and Jenkins valve discs are as familiar as A B C in the power plant. H. B. McLelland, representing the Chicago store of Jenkins Bros., displayed these and also the Jenkins gasket, tubing and other specialties of his firm.

CARRYING A FULL LINE of mill supplies and steam specialties, Field & Shorb Co., represented by Wilbur Batchelder and G. H. Strickler, filled its space with Palmetto, Rainbow and Peerless packings, with samples of Magnolia Metal good for bearings, with models of the product of the Ohio Blower Co., including the Swartwout exhaust heads, Swartwout separators and ball bearing ventilators, with the Daniels Ebonite and P. P. P. Packings, and with products of the U. S. Graphite Co.

REPRESENTING THE Garlock Packing Co., A. F. Mayer was present, but his exhibit did not, unfortunately, arrive in time to be put on display.

JOHN A. ROEBLING'S SONS CO. was represented by F. W. Hinterberg, Power by A. R. Maujer, and the National Engineer by John W. Lane and Robt. W. Larkin.

"LEAVES FROM A CHEMIST'S NOTE BOOK," "What a Lubricant Should Not Be," and a pamphlet entitled "And Jones Woke Up," served to explain to visitors at the space of the Keystone Lubricating Co. the advantages of a proper lubricant in its proper place. L. M. Scott looked after the company's interests.

SO MANY DIFFERENT THINGS were shown at the double space of the H. W. Johns-Manville Co. that it is impossible to enumerate them all, much less describe them. H. Aubrey was in charge and the Blue Book of Facts and Figures which he presented was worthy of most careful attention. Among the packings were Liberty and Kearsarge tubular gaskets, Kearsarge molded gasket, Permanite gasket, Kearsarge and Permanite sheet packings, pipe coverings for all purposes, including water lines, steam lines, ammonia and brine piping and for superheated steam. Special rubber goods including hose, spiral and ring, square and round packings and valve disks, and other specialties such as the J-M enclosed fuses, Transite shingles and Regal sheathings for sides and roof of buildings.

MEXICAN BOILER GRAPHITE for the mechanical cleaning of boilers was the topic of discourse by F. J. Lee at the booth of the U. S. Graphite Co. of Saginaw. This was less argument than exposition as the samples of old scale which had been taken off in sheets and flakes, even from what seemed like clean boilers, did not permit of much argument as to what the Mexican boiler graphite would do in removing scale and keeping it from forming.

DECATUR RAILWAY & LIGHT CO. showed many applications of electricity for industrial and domestic uses, such as the Emerson fan, the Wagner motor, Westinghouse and General Electric household specialties, etc.

A RACK OF OVER 90 grades of sample oils, and cans of Polarine grease for motors and Arctic cup greases for shafting were displayed by the Standard Oil Co., in charge of Theo. M. Campbell.

HAWKEYE COMPOUND, which is always a brick, was the subject of the advertising literature shown by T. Brommenschenkel and R. M. Rochfort for the Hawkeye Compound Co.

R. H. RAWSON, of Decatur, represents a number of companies having thoroughly tested steam specialties including among them products of the Anchor Packing Co., Tauril and Anchor packings, the hose and belting of the Maguire Rubber Co., specialties of the McMaster-Carr Supply Co., the Simplex blowoff valve, the traps of the Wright Mfg. Co. and separators of the Austin Steam Separator Co., White Star oil filters, Canton-Hughes pumps and the Murray automatic boiler feed regulator.

RENEWO VALVES with brass bodies, Duro blowoff valves and the Ferrenewo valves with iron bodies constituted the main features of the display of the Lunkenheimer Co. in charge of C. C. Rodenberg. The exhibit included also a full line of brass specialties of all descriptions for the steam plant and was set off by decorations of pinks and ferns.

W. H. SHENTON, in charge of the display of Schaeffer & Budenberg Co., had a line of Columbia recording gages and thermometers, of special protected thermometers for pipe lines, samples of durable gage glasses, and the S. & B. Orsat draft gage. The S. & B. portable gas analysis apparatus was so compactly put up and conveniently arranged that it can be carried about filled with chemicals, installed anywhere and tests of the flue gases made in a minute or less. In the Schaeffer & Budenberg steam indicators, a particular novelty was the gas engine indicator made especially for Diesel engines, a design which accomplishes something not heretofore satisfactorily worked out. Also the new design of S. & B. tachometer which has 4 scales reading by stages from 40 up to 4800 revolutions and which is so made as to be practically fool proof and wear proof. It has an overspeed stop which prevents it from operating if it goes above speed and is provided with wheels and disks so that it may serve as a cut meter or a surface speed meter.

A WORKING MODEL of the Wickes vertical boiler having a glass top to show the rapidity of circulation was the attraction of the exhibit of the Wickes Boiler Co., in charge of James Milne. The model was in every respect a reproduction of a Wickes plant, burned about 1½ quarts of gasoline per hour and evaporated 26 lb. of water per quart of gasoline. The boiler had 6½ sq. ft. of heating surface and was rated at 0.65 hp. The heat was so thoroughly extracted from the gases that the hand could be held on top of the stack, which was only about 4 ft. in height.

PLUMBING GOODS, reducing valves and regulating valves constituted the main features of the exhibit of H. Mueller Mfg. Co. They displayed also a revolving check valve which by means of the wings on the under side regrinds at every closing, also clears itself of all sediment and because of its rotating motion as it seats cannot hammer. The representatives in charge were P. J. Freeman and E. A. Mann.

IN VIEW OF THE FACT that the 1912 U. S. Standard for standard weight and extra heavy flanges and flanged fittings was not presented to the manufacturers for their approval before its adoption by the societies which approved it, the members of the Manufacturers' Standardization Committee have issued a notice to engineers and other users of valves and fittings that orders based on this 1912 standard will not be accepted by the manufacturers until certain necessary revisions have been made to suit the practical requirements of all concerned. This decision has been arrived at after a careful comparison of the 1912 standard with the manufacturers' standard, which has been in use for some time and which was adopted by the leading manufacturers as the result of many years of experiment. Difficulties are sure to arise in trying to use the new standard in plants where fittings of the old standard are already installed and the practical difficulties do not seem to have been given sufficient consideration when making the changes from the older standard. A committee of representatives of the various manufacturers has compiled a proposed standard taking account of the considerations above mentioned and this proposed standard has been presented to the committee of the American Society of Mechanical Engineers and of the National Assn. of Master Steam and Hot Water Fitters. The manufacturers feel that until this proposed standard has been considered and a universal standard agreed upon by all parties, the former dimensions should be considered as the ones to be used.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

THE GEBHARDT STEAM METER

THE construction of this meter is shown in a sectional view, Fig. 1. It consists of a water gage glass fitted to a special holder which is constructed so that the water of condensation will collect in the gage and the height of this water column will be a direct measure of the weight of steam flowing in the pipe. Connection to the pipe is by means of a ¾-in. nipple and different tubes are made adapted to pipes of any size and for any position.

Reading is taken from cylindrical chart, as shown in full view of the meter, Fig. 2. Each vertical line corresponds to a definite steam pressure and the spiral lines

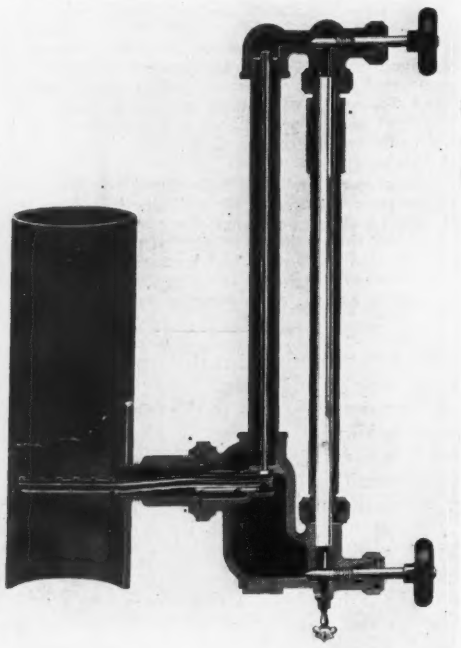


FIG. 1. SECTION OF THE GEBHARDT METER ATTACHED TO 3-IN. PIPE

to different rates of flow. When the reading is to be taken, the chart is turned so that the given pressure is in line with the edge of the pointer and the latter is then brought on a level with the water in the gage. The reading of amount of steam flowing is then taken direct.

It will be seen that there are no moving parts to the meter, that attaching it on a pipe requires only the insertion of a ¾-in. plug, and the process is no more difficult than that of putting on an ordinary pressure gage. The instrument shows the pressure in the line, the velocity of the steam in feet per minute and the pounds flowing through the pipe per hour.

The instrument is about the size of a common gage glass, weighs complete only 12 lb. and requires no stand or casing. The reading is as simple as that of any ordinary recording pressure gage and no computation is required. The care necessary is the same as for any ordinary gage glass and as there are no working parts and no wear, the useful life is limited.

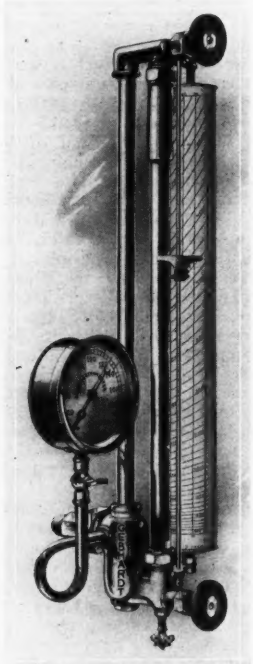


FIG. 2. GEBHARDT STEAM METER COMPLETE

The only change needed in attaching to different sizes of pipe is the use of an inner tube and a chart adapted to the size of the pipe, both of these being furnished at small expense for different sizes of pipes. The meter is made by the Steam Appliance Co. of Chicago, Ill.

A NEW IRON BODY GATE VALVE

THIS new valve, known as the Cino, is shown in the type used for small sizes in full view in Fig. 1 and sectional view in Fig. 2. In this type of construction, it is made for pipes from ½ to 4-in. and in all these it has the double disk feature with the attendant advantages.

Referring to the section view, Fig. 2, bronze disks (D) have a ball and socket bearing in the center, and are suspended from and held in position by a malleable iron wedge-shaped holder with lugs on either side which travel in grooves in the valve body. When closing the valve, these disks automatically rock into position, adjusting themselves on the ball and socket bearing in the center. This distributes the pressure uniformly and in-

sures perfect contact at all points. This action is supplemented by a wedging of the disk holder (F) which tightens the disks after they are in seating position. The flexibility of this double disk design compensates for any change in angle of the seats due to expansion and contraction, and even if one disk be obstructed by particles of dirt or scale, the other disk will hold tight.

Besides this, the double disk will enable the valve to take pressure from either side; the gate form gives full opening, which is desirable in handling thick or heavy liquids; and should any sediment accumulate in the pocket formed by the disks, it crowds up between the disks when closed and on the next opening is carried up and washed away.

FIG. 1. CINO IRON BODY VALVE WITH PLAIN HUB

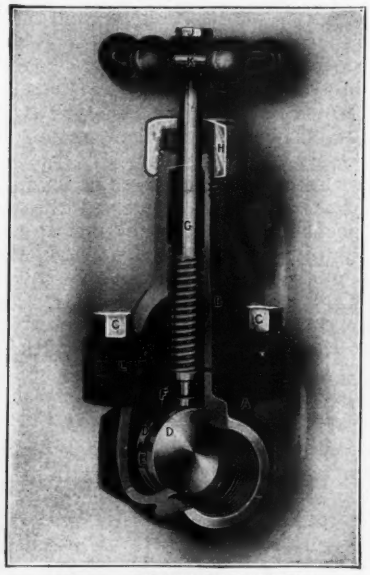


FIG. 2. SECTIONAL VIEW OF CINO GATE VALVE

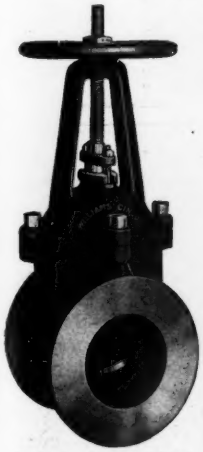


FIG. 3. IRON BODY GATE VALVE WITH OUTSIDE SCREW AND YOKE

FIG. 4. QUICK OPENING GATE VALVE WITH LOCKING STEM

Another valuable feature is that the disks are coupled to the disk holder so that they are free to revolve, and in opening or closing the valve, these disks, actuated by the pressure, make almost a complete revolution, which motion grinds in the disks and cleans the disk surfaces.

The body of the valve is of iron, the disks of bronze. The stem is of bronze of large diameter, having the Acme Standard thread, the female thread in the hub being tapped instead of cast, thus giving a good fit and smooth working. These valves are suitable for steam, water, oil, air or gas and are guaranteed for working pressures up to 100 lb. They are given a severe pressure test at 250 lb. in the factory and are warranted free from flaws and defects.

The valves are made for either screw or flange ends, all sizes have the rising stem. For pipe from ½ to 4 in., they are made with the plain hub, as shown in Fig. 1, and for 5 to 6-in. sizes, with outside screw and yoke, as shown in Fig. 3. For those who desire a quick opening gate, the valves are made with lever, as shown in Fig. 4, and with a slide stem fitted with a locking device so that the valve can be held at any degree of opening. The quick opening valves are suitable for pressure up to 50 lb.

These Cino valves are manufactured by the D. T. Williams Valve Co., of Cincinnati, O.

PUMP VALVE RESEATING MACHINE

FOR recutting the seats in the water valve chamber in all types of pumps, the new Dexter pump valve reseating machine will be found of great service. It can be quickly and easily attached and will accurately recut the valve seat in a few minutes time, giving an absolutely tight valve.

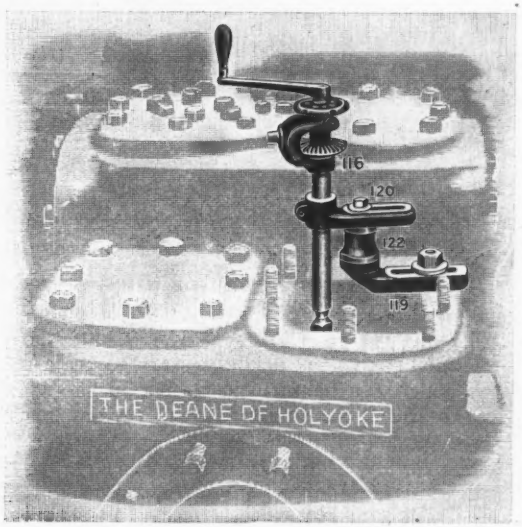


FIG. 1. DEXTER PUMP VALVE RESEATING MACHINE, TYPE H 6, AS ATTACHED TO A TRIPLEX PUMP

Figure 1 shows the machine attached to a triplex, double-acting pump as used for the lower valve. Seat-

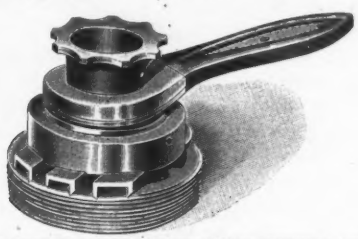


FIG. 3 THE SMITH & WILLIAMS PUMP CUTTER ATTACHED TO A PUMP VALVE CHAMBER

ings in the upper valve plate are recut in the same manner. The yoke, 119, is quickly bolted or clamped

to studs on the valve chamber and the seat is reseated by a few turns of the handle while turning the feed wheel slowly. Cutters are automatically self leveling and are of such form that they do not chatter.

Underwriter pumps and other forms where the seats are located so that there is not sufficient height to use the tool spindle, have the cutter operated as shown in Fig. 2. The valve bolt is used as fulcrum and feed screw, and a few turns of the ratchet accomplishes the result, the cap of the valve being turned slowly thus giving a light feed. The outfit H 6, as shown in Fig. 1, is suitable for all types of pumps

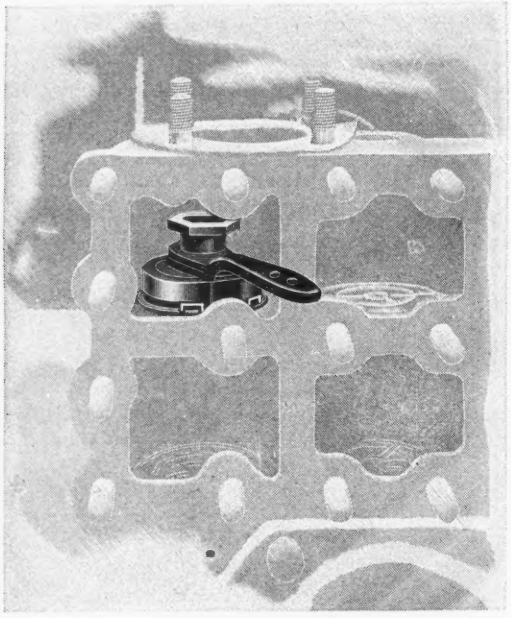


FIG. 2. RECUTTING PUMP VALVE SEAT INSIDE OF WATER CHEST BY THE DEXTER METHOD

with seats from 2 in. to 7.5 in.; for seats from 2 in. to 4 in. only, the standard type K 4 is suitable. For some special conditions it is necessary to use a special design, which can be furnished on request and operated with the same facility as the regular machine. The arrangement of the cutters as attached to a pump valve seat for low head room is shown in Fig. 3. These are all manufactured by the Leavitt Machine Co., Orange, Mass.

AUTOMATIC SPRINKLERS IN BOILER ROOMS

AN evening fire in the boiler room of the Cohoes Iron Foundry & Machine Co. is supposed to have been caused by a spark igniting some shavings in front of the boiler, either while raking out or putting on coal. One Grinnell automatic sprinkler was opened by the heat and put the fire out with a total damage of less than $10. A door and door casing were charred, but this was about the extent.

Sparks from the forge caused a recent fire in the boiler room of the Mattatuck Mfg. Co. (metal workers). The damage, which amounted to about $26, was confined to one window and part of a side wall. One automatic sprinkler head was opened by the heat and was assisted by fire pails in putting out the fire.

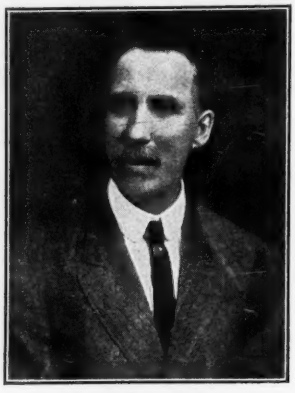
WILBUR E. RICHARDSON

ON May 15, Wilbur E. Richardson, president and general manager of the Richardson-Phenix Co., Milwaukee, Wis., died of apoplexy at his late home, 875 Island Ave., Milwaukee.

Early in life, Mr. Richardson served his time as machinist in the Marionette Iron Works, Marionette, Wis. He demonstrated his ability to cope with difficult problems in general power-plant work, and soon accepted the position of chief engineer of the Gilbert Paper Co., Menasha, Wis. The improvements and economies which he effected in this plant brought him into prominence and he was soon induced to enter the employ of the E. P. Allis Co., at Milwaukee, where he established an excellent record in the erecting and testing departments.

Later, while engaged in erecting pumping engines, Mr. Richardson conceived the idea of developing a mechanical cylinder-oil lubricator along new lines. He submitted his scheme to Edwin Reynolds, of the Allis-Chalmers Co., who thought so well of it that he gave Mr. Richardson his first order. The business was then established in a small way in Milwaukee.

In the fall of 1900, Mr. Richardson was sent to New York City to complete the installation of 11 5000-hp. engine units in the Ninety-sixth St. Station of the Metropolitan Street Railway Co. His successful work at this plant led to his promotion as the Allis-Chalmers



Co.'s superintendent of erection for the eastern district. Mr. Richardson took charge of similar installations in the Manhattan Ry. Co.'s Seventy-fourth St. power station, the Interborough Rapid Transit Co.'s Fifty-ninth St. station and the Brooklyn Rapid Transit Co.'s Third Ave. power station. Upon the completion of these installations Mr. Richardson was appointed general superintendent of all the work of the Westinghouse Machine Co.

In the meantime, the mechanical lubricator business which Mr. Richardson had established several years before had grown to such an extent that in 1907 he was enabled to sever his connection with the Westinghouse Co. and devote all of his time and energy to the design and manufacture of his company's products.

Mr. Richardson's inventive genius soon developed a number of important improvements for the economical application of oils to power-plant machinery, many of which are used to-day in the large power plants throughout the country.

His foresight and excellent judgment caused him to surround himself with a business organization that is in such excellent shape today that his sudden tak-

ing away, while a great shock to his associates, will not in any way interrupt the business.

Mr. Richardson was endowed with a strong and genial personality which had gained him wide and steadfast friendships throughout the country. He was a keen judge of human nature, and his memory will be particularly cherished by many engineers whom he had placed in good positions. He is survived by Mrs. Richardson and 2 sons.

MEETING OF THE NATIONAL GAS ENGINE ASS'N

THE next annual convention of this association, which meets in Milwaukee, June 17th to 22nd, will be in conjunction with the first gas engine show at the Auditorium Building in that city. The show will open on the 17th and the convention proper on June 19th. The reception of the gas managers will be held on June 18th and they will consider the topic of future rates, whether the present system of oil inspection is of any value, whether present insurance rates of the board of underwriters are satisfactory and whether it is advisable to adopt a standard guarantee for all combustion engines.

On Wednesday, the managers of the association will meet again, taking up the report of the Publicity Committee and other committees; papers will be presented on Lubrication and What It Means, by A. E. Potter, of New York; on Oil Engines, by A. O. Krieger, of St. Louis; on Gas Engines for the City, by H. W. Jones, and on Gas Producers, by J. N. Latta.

Thursday, the 20th, will be devoted to farm power and Friday to Publicity, taking up Publicity Through the Trade Journal, by E. R. Shaw, of Practical Engineer, the discussion continued by W. R. C. Smith, of Atlanta, Ga.; Direct Advertising by Dealers, by C. H. Hall, of Milwaukee, Wis., and General Publicity, by F. E. Long, of Chicago.

No charge will be made to the Power Show. Tickets of admittance to convention and to entertainments will be procured from the exhibitors or members and numbered badges will be furnished entitling holders to admittance to all entertainments and meetings except executive sessions.

In order to get some data on the present condition of gas industry, H. W. Jones, 461 Peoples Gas Bldg., Chicago, has sent out blanks asking questions as to the number of engines made in 1911, their average horsepower, total number in use at present and their anticipated orders this year. Over 12½ per cent of the blanks were returned by the middle of May and it is hoped that those who did not return these blanks will do so at once.

NEWS NOTES

THE OHIO BLOWER CO., of Cleveland, Ohio, has recently removed to its new quarters at 5125 Perkins Ave., where all business will in future be conducted.

THE OHIO BRASS CO. ADVISES THAT, becoming effective at once, Mr. E. L. Murray succeeds Mr. F. A. Buss as Chicago representative, with headquarters at the Chicago office, room 508, Fisher Building. Mr. Buss has resigned his position to engage in other business.

THE CONTINUAL GROWTH of the business of the Lagonda Mfg. Co., at Springfield, Ohio, makers of the Weinland boiler tube cleaners, Lagonda cutoff valves, water strainers, etc., has made necessary the erection of a new 3-story modern office building. The present office is located in one end of the factory building, but the need of additional factory space, as well as greater office facilities, has rendered the new office building necessary. The building will be of reinforced concrete and of fireproof construction throughout, and will be thoroughly equipped with all of the modern office labor-saving devices which will enable the Lagonda Mfg. Co. to handle with the greatest possible dispatch all inquiries concerning any of their apparatus.

ANNOUNCEMENT has been received too late to learn more details of the death, on May 27, of Theodore Albert, president of the Wm. Powell Co., at his home in Cincinnati.

THE DEARBORN DRUG & CHEMICAL WORKS have removed their Indianapolis office to 919 Hume Mansur Building. Mr. J. F. McDonnell has succeeded Mr. Clark, as Manager of that office, Mr. Clark resigning June 1, to take charge of the Acme Engineering Company.

ANNOUNCEMENT IS MADE that the consulting metallurgical business conducted by E. F. Lake at Bayonne, N. J., has been merged with the metallurgical engineering firm of Nixon & Raab, under the name of Lake, Nixon & Raab at 156 Fairview Ave, South Orange, N. J.

THE FEDERAL METALLIC Packing Co. of Boston, Mass., has moved from 146 Canal St. into larger quarters at 48 Hanover St. New machinery is being installed in the new location to care for the increase in business.

CATALOG NOTES

U. S. AUTOMATIC INJECTORS is the title of a neat little catalog issued by the American Injector Co., of Detroit. It illustrates and gives prices of the many specialties given by this company.

WE HAVE RECEIVED FROM Nagle Corliss Engine Works, Erie, Pa., Catalogs 3, 7, 9 and 15, covering the subjects of Nagle 4-valve engines, Class G engines, Class H engines and class A and B air compressors.

IT'S IN THE WINGS, is the title of a booklet distributed by the H. Mueller Mfg. Co., giving the features of its nonfouling turbine check valves. The operation of these valves is controlled entirely by wings which are fastened to a stem passing through a disk. When the wings are rotated by the entering fluid the disk is unseated, thus opening the valve.

CORLISS VALVE STEAM TRAP and steam separators is the title of an exceedingly interesting catalog issue by John L. Lindstrom Machine Works, Allentown, Pa. As the title implies, the text is devoted to the description of steam traps and separators. Improved Patented Corliss Valve Steam Trap made by this company automatically drains any excess flow of water in the pipes under all pressures and without waste of steam. Furthermore this result is accomplished without any complicated mechanism. Simplicity is also one the chief claims of the Lindstrom Steam Separator.

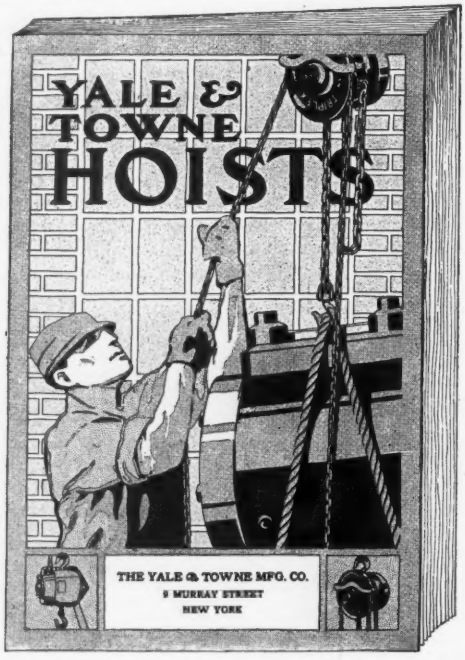
In addition to the descriptive matter there is embodied complete instructions for setting Corliss engine valves, which will be of value to every engineer. Copies of this catalog will be gladly sent upon request to any interested person by mentioning Practical Engineer.

BULLETIN 4930, recently issued by the General Electric Co. is devoted to the application of electric drive to ice and refrigerating plants, and illustrates the advantages offered by this method of drive. The bulletin contains illustrations of various installations of electric motors in connection with industry.

THE FRANCE GAS CONSUMER CO., Matteawan, N. Y., sends out a booklet entitled "Smokeless Chimneys, How to Comply with the Smoke Ordiance," which shows the construction of its gas consumer as applied to both water-tube and return tubular boilers. The benefits to be derived are specified as saving of fuel, prevention of smoke, increased absorption of heat and fewer leaky tubes.

THE 1912 BOOK OF HOISTS gives practical information, pictorially and in tabulated form, for the busy superintendent who looks to economies of handling.

This country and Europe have been searched for examples of the latest application of hoists. The best practice is shown in each case from the block-beam properly installed over the shipping dock to the motor-driven hoist-vehicle, with its operator suspended on a net work of tracks.



The greatest economies are being practiced today by supplementing the service of cranes with hoists in a variety of uses, as these views of model plants plainly show. The trolley has come into general use on low ceilings, and where obstructions of floor space are unavoidable, thanks to the great compactness of the built-together hoist and trolley. A copy of the Book of Hoists can be obtained by writing Yale & Towne, 9 Murray street, New York city.

ALL CONNECTED WITH the metal mining industry will find Bulletin No. 4922, devoted to electricity in metal mines, issued by the General Electric Company, very interesting.

The bulletin illustrates and describes several modern installations of electric mining machinery.

GENERAL ELECTRIC COMPANY has recently issued Bulletin No. 4933 describing its small polyphase motors of the riveted-frame construction. The motors are for 2 and 3-phase circuits and wound for 25, 40 and 60 cycles. They range in capacity from ¼ to 15 hp.

The bulletin describes both horizontal and vertical motors, and contains illustrations of various applications of the motor.

A STORY BOILED DOWN is the title of a book issued by the American Engine Co., Bound Brook, N. J., which covers in the form of pictures the advantages of American-Ball Angle Compound engines. It illustrates the angle cylinder arrangement, the efficient lubricating system, the valve gear, governor, small floor space, the absence of pounding, and the unbalanced forces and vibration and how angle compound engines are used in isolated plants. Copies of this "Story Boiled Down" will be sent to all engineers writing to the above company.

PEERLESS RUBBER MFG. CO., 16 Warren Street, New York has brought out a new catalog which should prove a valuable addition to the business libraries of Engineers, Master Mechanics, Purchasing Agents and others who buy or use mechanical rubber goods such as Packings of all kinds; Gaskets; Rubber and Canvas Belting; Water, Air, Steam, Gas and Acid Hose; Rubber Matting, Sheet Rubber Tiling, etc. There are very few of the 200 pages without a finely executed engraving, showing a product in its natural colors, and a dozen or more of them are full-page colored plates. In making up this book careful consideration has been given to the convenience of customers in finding quickly the information desired, and much information of value to Engineers, aside from that pertaining to the Company's products, has been included. The book is beautifully printed in a three-color effect, on a high quality of coated paper, and is bound in limp covers. It is designated as Catalog 100.

REFILLABLE CARTRIDGE fuse shells for light and power circuits are described and their uses explained in Catalog No. 15 distributed by the manufacturers, A. F. Daum & Co., Pittsburgh, Pa. A feature of these brass and fiber shells is that the same size shell may be used for many different sizes of fuse wire, a 30-amp. shell being suitable for use for any number of amperes from 1 to 30.

FROM JEFFREY MFG. CO., Columbus, Ohio, we have received general Catalog No. 82, which illustrates and describes Jeffrey elevating-conveying power transmission machinery and coal mine equipments. This is a book of nearly 600 pages, bound in cloth and makes a valuable addition to the file.

FROM OIL CITY BOILER WORKS we have received Catalog H-3 illustrating and describing Oil City heating boilers for steam heating and hot water warming, also a descriptive booklet on the subject of the Geary water tube boilers.

THE CONSOLIDATED ENGINE STOP CO., of New York City, have just issued Bulletin 41 describing its automatic engine stop and speed limit systems. It describes combination engine stop and throttle valves; automatic valve stops for placing in the steam line and engine stops for attaching to present throttle valves.

BULLETIN NO. 58, of the Industrial Instrument Co., of Foxboro, Mass., is on Thermometers and Thermographs for indicating and recording temperature; it shows the dial type for long distant readings and records, gives the details of construction and shows the different registers which are furnished. Descriptions of the thermograph or recording thermometer are particularly interesting, also the data which may be obtained by its use.

Sparks From The Advertising Pages

The response to our request for letters selecting the best advertisements from the May issues of Practical Engineer has been exceedingly large. Engineers have replied not only from every part of the United States, but from Canada and abroad.

It has therefore been very difficult to choose the fifty letters which have seemed to be the best, for the replies have been as universally good as they have been numerous.

After careful consideration, the letters written by the following fifty men were chosen in the order in which they are mentioned.

(1) The best five: Roy W. Eves, Engineer in charge B. & O. S. W. R. R. Co., Chillicothe, O.; Frederick L. Ray, 1036 Edwards Ave., Louisville, Ky.; Thos. C. Robinson, care of J. C. Sanders, Ft. Madison, Ia.; David R. Shearer, Box 22, Knoxville, Tenn.; Geo. Van Vlack, 272 Emerson St., Rochester, N. Y.

(2) The next best ten: A. Linker, 224 S. Thayer St., Ann Arbor, Mich.; Leo. H. Weinkle, Valdosta, Ga.; W. S. Heckendorn, Flandreau, S. Dak.; William E. Dixon, 35 Orient St., Malden, Mass.; Joseph Bowman, 641 Montgomery Ave., Elizabeth, N. J.; J. C. Hawkins, Hyattsville, Md.; Geo. F. Osthoff, Box 13, Hoisington, Kans.; C. J. Cazeau, 94 Kingston St., Rochester, N. Y.; H. C. Combs, B. 4804 21st St. and Fairmont Ave., Philadelphia, Pa.; Herbert J. Stake, P. O. Box 125, New Hampton, Ia.

(3) The third best ten: Archibald Thomson, 30 Third St., Pittsfield, Mass.; Fred C. Becker, P. O. Box 361, Freeland, Pa.; H. I. Geake, 920 Russell St., Victoria West, B. C., Canada; Jas. A. Lysaght, 2714 Duncan St., St. Joseph, Mo.; A. M. Meyers, 39 Letchworth St., Buffalo, N. Y.; Frank Witts, Sullivan, Ills.; John Craig Scott, 3811 Dawson St., Pittsburgh, Pa.; Edw. J. Rose, 167 Harper Ave., Detroit, Mich.; Geo. A. Shipe, Benton Ills.; Abe J. Oling, care of Pumping Sta., 104th St. and Vincennes Rd., Chicago, Ills.

(4) The fourth best twenty-five: Donald Johnston, R. R. 4, Box 63, Newburgh, N. Y.; V. E. Senander, Webb, Sask., Canada; V. C. Wood, Copenhagen, N. Y.; E. A. Wooster, P. O. Box 194, West Mountain, Naugatuck, Conn.; Percy Jones, 905 Flynn Ave., Alva, Okla.; L. H. Sisson, 18 Amity St., Muskegon, Mich.; A. Chas. Fortenbaugh, Mico, Tex.; Chas. Fenwick, Strome, Alta., Canada; Captain Martin Sorenson, Box 656, Bemidji, Minn.; John Tepp, 63 30th St., Milwaukee, Wisc.; Clyde Myers, Box 44, Homer City, Pa.; Clyde R. Weihe, 402 E. Francis Ave., Connellsville, Pa.; Leon L. Pollard, Box 172, Fairfield, Me.; Albert Wright, R. F. D. 9, Noblesville, Ind.; D. W. Stults, care Fireman's School, Box 83, Fortress Monroe, Va.; W. A. Jones, 2276 Auburn Ave., Toledo, O.; Henry G. Paquin, 9 Flynn St., Lebanon, N. H.; E. Waldron, 1904 Highland Ave., Knoxville, Tenn.; N. J. Schang, East Aurora, N. Y.; A. Karreman, Jr., Grand Rapids, Mich.; Chas. M. Lefler, Johnson, Mont.; C. E. Anderson, 6942 Morgan St., Chicago, Ill.; Joseph J. Pire, Ft. Stevens, Ore.; J. L. Stewart, 2217 Court St., Sioux City, Ia.; W. L. Dimmick, Oxnard, Calif.; John S. Bell, Weeks Bros. & Co., 167 Richmond St., Providence, R. I.

Roy W. Eves, of Chillicothe, Ohio, has written one of the best letters, which we print below:

Chillicothe, Ohio, May 27, 1912.
Advertising Editor: Practical Engineer,
537 S. Dearborn Street,
Chicago, Ill.

(1) *The advertisement of The Harbison-Walker Refractories Co. has the strongest attention value, partly on account of its position on the front cover and partly on account of its wording. The question, "Do you want to know more about Boiler Settings?" is bound to attract the attention of any progressive engineer no matter how well up he is on boilers.*

(2) *The most interesting advertisement is that of the General Electric Co. (May 15th) as it gives information concerning the most modern type of prime mover and a giant of its kind. In the cut the details of the turbine are brought out clearly and it is worth studying. Ads like this tend to broaden and to educate the engineer of even the smallest and of the largest plants.*

(3) *The most convincing advertisment is that of the Cling Surface Co. (May 1.) Clear and easily understood illustrations of the properties of its product are given. Many previous advertisements of this company making similar claims also, give the reader confidence that the claims are true.*

(4) *I answered the following advertisements: Cling Surface Co., Lunkenheimer Co., Gutta Percha Rubber & Mfg. Co., Keystone Lubricant Co., Sculley Steel & Iron Co.*

Respectfully submitted,
Roy W. Eves,
Engr. in Charge, B. & O. S. W. R. R. Co.

Mr. Eves has backed up his selections with definite reasons why. Frederick L. Ray, of Louisville, Ky., has done likewise; yet these two engineers differ widely, not only in their selection of the best advertisements, but in the advertisements which they answered. There is not a single duplication. Mr. Ray's letter:

Louisville, Ky., May 29, 1912.
Advertising Editor: Practical Engineer,
537 S. Dearborn Street,
Chicago, Ill.

(No. 1) *I consider the advertisement of the Peerless Rubber Company, TO HAVE THE BEST ATTENTION VALUE, because you cannot help but be attracted by the words at the top of the page, "I CAN'T SHUT DOWN NOW," and of course you will read what follows, in order to know what the trouble was. The characters portrayed are fine and the subject matter is brought to the reader in the fewest possible words, with an excellent arrangement as a whole.*

(No. 2) *The advertisement of The Engineer Company, New York City, is the most interesting because of the statements made of NO BOILER REPAIRS, for who of us would not be interested in a device that would eliminate boiler repairs.*

(No. 3) *The advertisement of the Ingersol-Rand Company was very attractive and the MOST CONVINCING because of the POSITIVE STATEMENTS made of RESULTS ATTAINED in actual service and to one who was considering the purchasing of a machine it was most convincing and warranted further investigation.*

(No. 4) *I have answered the following advertisements: Ingersol-Rand Company, The Schaeffer & Budenberg Mfg. Co., S. F. Bowser & Company, Inc., The American Well Works.*

Yours very truly,
Frederick L. Ray,
No. 1036 Edwards Ave.

It is interesting to note that although Mr. Ray answered four advertisements, only one of the four was among the three which he selected as the best. This shows that a reader can be interested whether he is in immediate need of the product advertised or not.

It is an excellent example of what is called the cumulative value of advertising. While no direct answer was secured in these particular cases, an impression was made which is pretty sure to develop into a direct return in the future.

RECENT SALES of pressure regulators manufactured by the G. M. Davis Regulator Co., Chicago, have been made to the National Tube Co., Diamond Match Co., International Harvester Co., National Biscuit Co., Swift & Co., Thos. A. Edison Co., International Paper Co., Pennsylvania Rubber Co., Fred Rueping Leather Co., Bethlehem Steel Co., B. F. Goodrich Co., Pennsylvania Steel Co., Lake Superior Paper Co., and others. The Davis was one of the first successful automatic reducing valves made in America and has wide distribution and is used extensively today, as shown by the above sales, in all kinds of steam operated plants where it is necessary to use steam at a pressure lower than that which is carried on the boilers.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 30 cents per line. About nine words make a line. No display type allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office 10 days preceding publication.

Positions Wanted

POSITION WANTED—A modern record keeping engineer, who can submit detailed report of operating expenses monthly, wants to engage with a live firm which contemplates building new steam power plant, of medium size, or remodel old one so as to pay profits. Will take full charge of all work pertaining to installation, generation and transmission of power, and selection of equipment and supplies. Married. Aged 39. Sobriety unquestioned. Gilt-edge references. Address Box 230, Practical Engineer, Chicago, Ill. 6-15-1

POSITION WANTED—By a stationary engineer who had experience with high speed and Corliss engines, condensers, a.c. and d.c. dynamos, and motors; has own steam indicator, and holds chief engineers' license for Minnesota. Can give A1 references. Address Box 231, care Practical Engineer, Chicago, Ill. 6-15-1

POSITION WANTED—Young man desires position in large plant where there is a chance for promotion. Two years' experience. Address W. K. Mann, Box 21, Milan, Mo. 6-15-1

POSITION WANTED—As chief or operating engineer, 10 years' experience on all kinds of steam and electrical power plant machinery. Age, 38; temperate, steady and reliable. Chicago City and State of Minn. chief engineer's license. Address Box 228, Practical Engineer, Chicago, Ill. 6-1-1

POSITION WANTED—By a college engineer, 31 years, single, with over 6 years' outside experience in the running and setting up of steam, gas and gasoline engines of all kinds. Address Box 226, Practical Engineer, Chicago, Ill. 6-1-1

Help Wanted

WANTED—EXPERIENCED SPECIALTY SALESMAN in every large town in U. S. Must be a live wire and acquainted with manufacturing trade. Proposition is high grade. Must be financially able to carry small stock for immediate delivery; also capable of appointing and directing agents. Good man can easily earn $3,000 to $5,000 yearly. Address with references. Box 229, Practical Engineer, Chicago, Ill. 6-1-1

WOULD ONE HUNDRED DOLLARS per week interest you? Would you like to be outside in the fresh invigorating air during the coming months? Free to do your own bidding and earning $100.00 or more per week, as you choose? Your own boss. We want one first-class salesman to represent us, in every city in the United States, to sell our high-grade specialties to Engineers. Exclusive territory given. Strong Machinery & Supply Co., 48 Franklin St., N. Y. C. tf

REPRESENTATIVES WANTED—Traveling representatives selling supplies to ice manufacturers and others engaged in the refrigerating industry, and who have spare time for an agreeable side line, can make advantageous arrangement by addressing A. Smit, Room 1004, 116 Nassau St., New York. 6-1-2

AGENTS WANTED—WE WANT a live-wire agent, either engineer or specialty salesman in every town to furnish lists of names and take orders for Akron Metal Gaskets, the most complete line of metal gaskets made. Write for our proposition. Akron Metallic Gasket Company, Dept. PE., Akron, Ohio. tf

HELP WANTED—ENGINEER WANTED in every city and town to instruct our customers in indicator practice. If you have a fair working knowledge, we will "do the rest." Good pay to reliable, intelligent men. Write for particulars. Lippincott Co., Newark, N. J. tf

WANTED—SALES AGENTS to sell Goetze Metallic Packings of good reputation. Write us. Goetze Gasket & Packing Co., New Brunswick, N. J. 6-15-2

Wanted

WANTED—EVERY ENGINEER to have our pamphlet for setting valves on Corliss Engines, simple and compound, with one and two eccentrics. Sent free. Lindstrom's Machine Works, 200 South Third St., Allentown, Pa. tf

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf

IF YOUR ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write the Subscription Dept. They will start you in at once. tf

For Sale

FOR SALE—INDICATOR, REDUCING WHEEL, planimeter, best make, in fine order. Examination allowed before payment. Price low—in fact, a sacrifice. Address Mrs. N. L. Browning, East Orange, N. J. tf

Patents and Patent Attorneys

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Building, Washington, D. C.

PATENTS OF VALUE—Prompt and efficient service. No misleading inducements. Expert in Mechanics, Book of Advice and Patent Office Rules free. Clements & Clements, Patent Attorneys, 727 Colorado Bldg., Washington, D. C. 5-15-6

PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf

Educational and Instruction

FREE TUITION BY MAIL—Civil service, drawing, engineernig, electric wiring, agricultural, poultry, real estate, automobile, law, normal, academic, bookkeeping, shorthand courses. Matriculation, $5. Write for our free plan. Apply to CARNEGIE COLLEGE, Rogers, Ohio. 5-15-6

Miscellaneous

IRON, BRASS and Aluminum Castings, Metal Specialties, Patterns, Models, Polishing, Plating and Japanning, North Chicago Tool Works, 65 Grove Ave., North Chicago, Ill.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. M. Y. C., 1413 W. Jackson Blvd., Chicago, Ill. tf

MAKE MONEY on the side. Here's your chance to pick out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you how. tf